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ABSTRACT

This collection of study units focuses on the study of the ecology of land habitats. Considered are such topics as map reading, field techniques, forest ecosystem, birds, insects, small mammals, soils, plant ecology, preparation of terrariums, air pollution, photography, and essentials of an environmental studies program. Each unit contains instructions and materials lists necessary to implement the lessons contained in the unit. (RE)

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AUTHOR ST. ANSELMS COLLEGE MANCHESTER PUBLIC SCHOOLS, N. H.
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TERRESTRIAL ECOLOGY GUI

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SE 028 813

St. Anselm's College
Manchester Public Schools
Manchester, New Hampshire

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I

INTRODUCTION

TEACHERS' GUIDE TO TERRESTRIAL ECOLOGY

It is not the intent of the writers to cover all aspects of the field of "Terrestrial Ecology." This would be impossible in a guide, especially one of this type, although the subject matter is interconnected and continuous. This is not true of terrestrial ecosystems as they are broken up by oceans separating them and other geological barriers of great importance. These barriers dictate the types of ecosystems that will exist on either side, the organisms and their interaction. There are many; who is to say what is the best for any one group of students or for any one community. It is with this in mind that we deviate from the traditional path and the usual "Air, Soil and Water" routine. The environmental problems we face today are not limited to the soil, water, and atmosphere. Instead, we have elected to delete water in this issue, as we covered it in our first "Environmental Studies Guide" and in its place we are introducing several topics designed to enhance the study of terrestrial ecosystems.

It is hoped these topics will add greater perspective, increase clarity and make the studies more interesting, leading to inquiry, self-involvement, and independent study on the part of the students. For many years we have wasted our forests and destroyed much of our wild life. Part of this destruction was the timetable result of agricultural development and the growth of cities. However, much of it was the result of greed, carelessness, and indifference. A complete conservation program will contain not only improvement of the physical environment but restoration of our forest and wildlife as well. One means by which we can lessen the misuse of our environment is by the education of our youth in the wealth of natural beauty of the terrestrial ecosystem. With this in mind, as we turn to this study we have included two units so that beauty will not be marred by people becoming lost or students straying from the path. We include the units on the Brunton Compass and maps.

Many of us have been turned around in the forest, in the mountains, and on the barrens on several occasions. To put it in simpler language, we were lost! We hear each year of people dying on the mountains of the world because they were lost. In most cases they never had a compass, or never knew how to use one correctly. We chose the Brunton compass because it is further used as a surveyor's tool and we find it useful in measuring areas, determining longitude and latitude, in conjunction with our mapping, in reporting areas that contain rare or endangered species to proper authorities. It is further used in geology studies as it measures altitude, dip, and angles. It is our belief that no student should be taken on a field trip into a dense forest or a large tract of forest land, or up into rugged mountain terrain, unless he is at least schooled in the use of simple compasses.

A unit on map making and map reading has been included, because it lends itself to the above unit, and again offers obvious safety inclusions. It further ties in with many other terrestrial study units not offered in this guide that will assist the students in further studies and in life's work and pleasures. Everyone looks at maps some time in life and is confronted with a mass of symbolism and confusing lines and graphs. Hydrological cycles, weather maps, T.V. weather forecasting, and many other areas, require knowledge in map reading.

The photographic unit was included because in four years of funding by the U.S. Office of Education, Environmental Education Office, the editors of this guide have seen first-hand the tremendous need for this type of educational material. It not only lends perspective and clarity to the study under consideration, it further lends an area of personal involvement where students can become the "instructors" and it can be easily transferred to the adult community by slide shows, lectures, and demonstrations. In choosing all the other units in this guide, the editors have selected articles from teachers and students, that have contained the extraordinary, the personal touch. Although these articles cover the well-known areas of ecology and biology that include "Birds, Insects, Small Mammals, Soils, Air and Plants" each writer has added a personal touch by introducing his or her own tools that were constructed by either themselves or their students. Our unit on field trips are self-explained in the article. We have further included an overview of a syllabus for terrestrial studies for the beginning teacher as added direction.

The teachers who were selected to write these units were provided with the articles written by various teachers and students, and other materials. The writers of these articles in this studies guide are dedicated teachers, and are students of environmental education. St. Anselm's College and the Manchester Public School System, co-sponsors of this Office of Education, Environmental Education Office Grant, along with editors, wish to acknowledge their debt and their gratitude to the authors.

We are further indebted to the following for sharing their own materials, thoughts, and time in many consultations: Mr. Joseph Chadbourne, Institute for Environmental Education, 8911 Euclid Avenue, Cleveland, Ohio, 44106; Dr. Dean Bennett, Project PREPARE, Middle School, Yarmouth, Maine; Mr. Sam Zaitlin, Maine D.E.P.; and other friends of education throughout New England who have encouraged our activities.

The Editors:

James W. Morrison, St. Anselm's College
James A. Hall, Manchester Public Schools

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9. Steven Hadlock - Photography.
10. Gary Netsch - Soils and the Brunton compass.
11. Barry Wolper - Terrariums and photography.
12. Andrea Wolper - Illustrations (Teri Terrarium).

The Editors feel special thanks are in order for Charles Quinn, Principal of West High School, for his many favors and all those teachers who helped in each and every way to make this possible.

The Editors: James A. Hall, West High School
James W. Morrison, St. Anselm's College

December 31, 1975

II

CONTOUR MAP READING AND ACTIVITIES

Map reading and interpretation is probably one of the most useful skills for anyone participating in any sort of fieldwork. Its usefulness, however, is dependent upon the mapreading experience of its user. Map skills are developed through a continued exposure to a variety of map situations and problems. In the pages that follow a variety of activities to familiarize a beginner with principles of contour mapping is presented.

Problem #1: Construction of a Map from Model

Several scientific supply houses distribute a plastic map model kit which is extremely useful in deriving many principles of contour maps (see Figure 1). If, however, such models are unavailable similar models can be constructed with modeling clay or plaster of paris. Transparent show boxes or other suitable substitutes can be easily obtained through local sources.

Students using map model kits are instructed to mark a box in half-inch intervals, from bottom to top, half-inch, with marking crayon. Next, with model in box, water is added until it reaches a mark. At each mark the box cover is added and contact between between water and model is drawn as observed from the top. It should be noted if water is not available. Fine grainted sand leveled off is suitable.

Students find they are representing a 3-dimensional model on a 2-dimensional surface. When completed comparisons can be made between the actual working model and map constructed from that model.

Points brought out by this comparison are listed below:

1. Elevation along any one line (contour line is the same.

2. Change in elevation between any two successive contour lines is always the same (contour interval).

3. Peaks are represented by concentric circles.

4. Steep slopes are represented by closely spaced lines. Gentle slopes are represented by widely spacing contour lines.

5. In areas where a river channel has been cut into the slope the contour lines bend upstream in order to maintain the same elevation.

6. Some students find that the water model contact point just before final submergence of our model has actually yielded two circles. One level circle is on the outside slope of our volcanic model whereas the other circle is the same elevation on the inside of our crater.

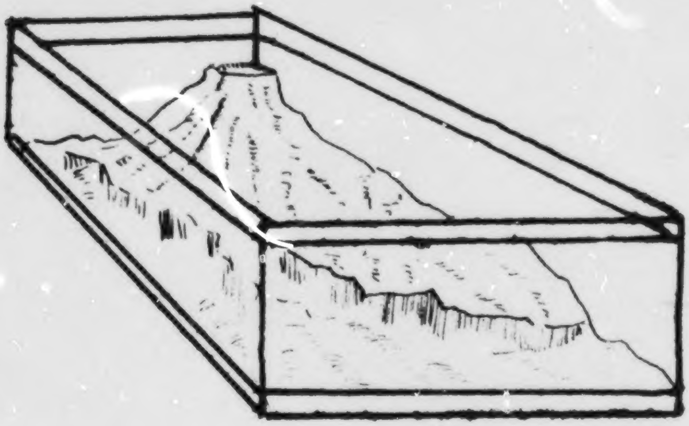


FIG. 1 VOLCANIC MODEL WITH TRANSPARENT PLASTIC BOX

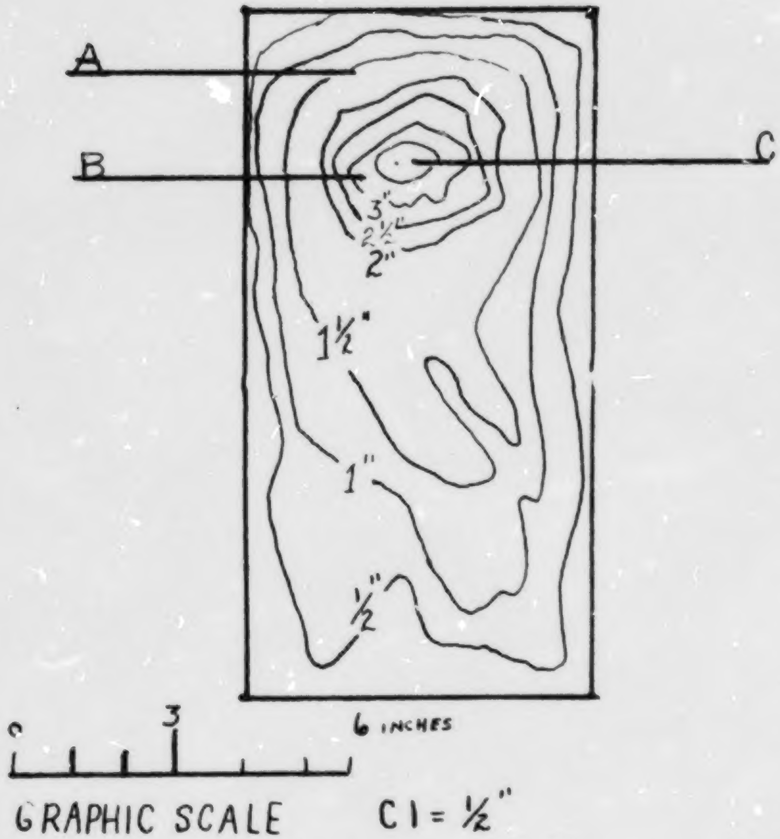

A
B
C
3"
2½"
2"
1½"
1"
½"
0
3
6 INCHES
GRAPHIC SCALE
CI = ½"

FIG. 2 CONTOUR MAP OF CONTOUR MAP MODEL

In actual mapping of this situation and to avoid confusion closed depressions are shown by the use of hachure lines. Hachure lines are drawn perpendicularly to contour lines and point in the direction of the depression (see map Figure 2). On both our model and map the regular contour line and the hachure line next to it have the same elevation. Problem 4 of this section will consider the problem of hachure line interpretative in more detail.

7. Finally, if we assume our model was constructed on a horizontal scale of 1 inch equal to one mile, we can construct a graphic scale as shown in Figure 2. By utilizing the graphic, the horizontal distance between any two points or series of points can be determined.

Additional Problems (Volcanic Map Model)

1. If a river were present on this map where might it be located? What direction would it flow (assume direction as shown on map in Figure 2)?
2. What is the area in sq. inches covered by this map?
3. Give elevations at points A, B, and C. NOTE: If point is located on contour line give the value for that contour line. If point is located between lines give the range of elevations.

Problem #2: Map Interpretation--Give Information Asked From Map in Figure 3

1. Contour interval.
2. Direction of flow of Red River.
3. Horizontal distance between A and B.
4. Highest Elevation.
5. Lowest Elevation.
6. Elevation at:

A ____________________ B ____________________

C ____________________ D ____________________

E ____________________ F ____________________

Problem #3: Construction of a Profile

One method of actually visualizing what is being depected by our strong array of contour lines is by constructing a profile. A profile is an outline along the air-land interface across a given base line.

Consider the task of constructing a profile across base line AB in the map in Figure 4.

Figure 4: Directions

1. Place a strip of paper across line AB and mark points A and B. Proceed to cross paper and insert mark where contour line intersects the paper.
2. Insert the value for each contour line on the piece of paper.
3. On separate paper construct horizontal and vertical scale as shown in Figure 5. Consideration must be given to the length of each scale. The vertical scale chosen must be adequate to represent the total relief across base line. The horizontal scale must be equal to the length of our base line.
4. Transpose values from paper onto horizontal scale labeling each point with its proper elevations.
5. Examine map across base line AB for points of minimum and maximum elevation.
6. Begin vertical scale (at origin) with minimum elevation and continue to extend until maximum elevation is reached.
7. Move on the vertical scale to points opposite those on the horizontal scale to appropriate elevation.
8. Interpret what's happening between points and draw profile. It should be noted that at the lowest and highest points across base line AB the direction of our profile will change (as troughs and peaks are crossed).

Construct profile CD and EF from map in Figure 6 and vertical scales given in Figures 7 and 8.

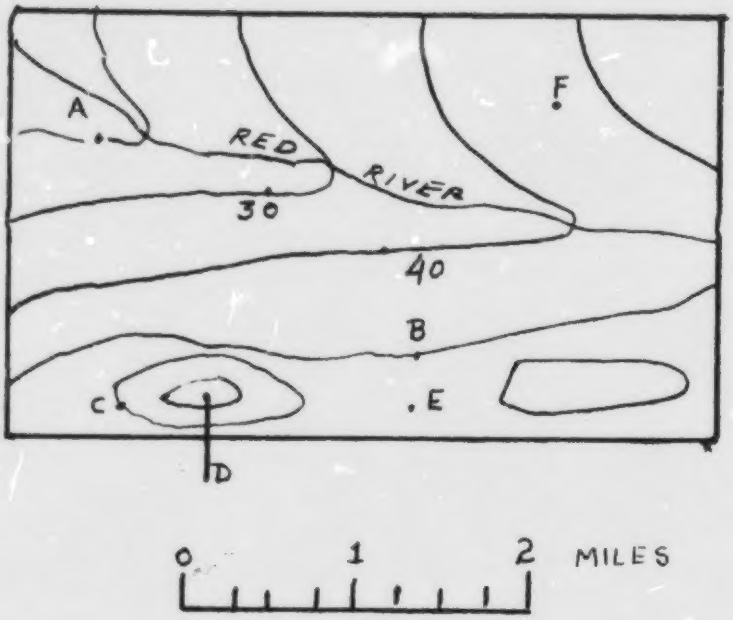

A
F
RED
RIVER
30
40
B
C
E
D
0
1
2
MILES

FIG. 3

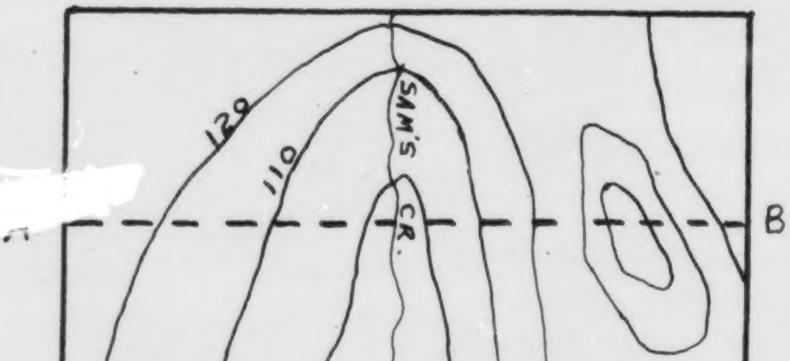
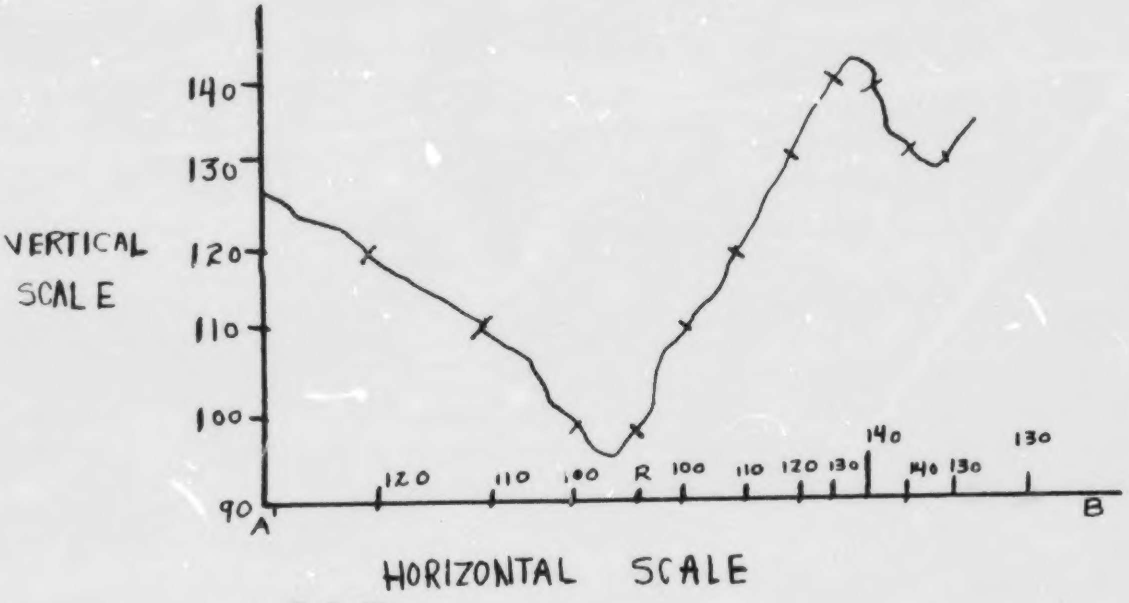

120
110
SAM'S CR.
A
B

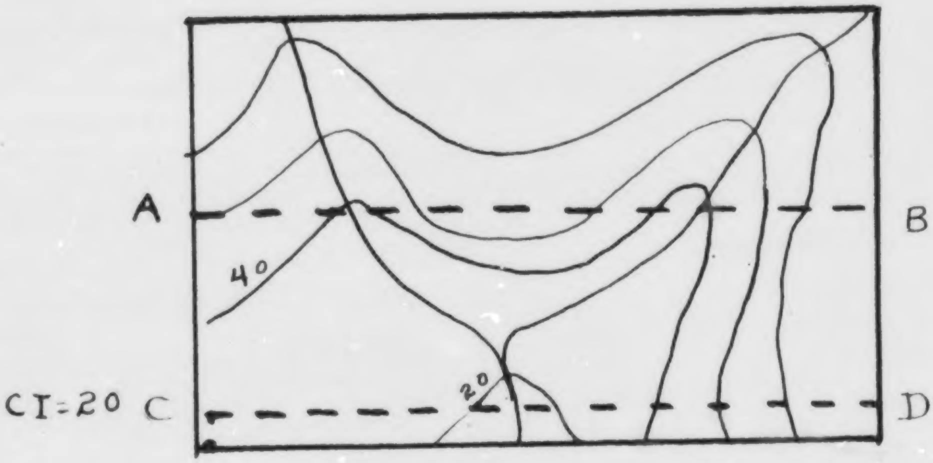
FIG 4

CI = 10



VERTICAL SCALE
140
130
120
110
100
90
A
120
110
100
R
100
110
120
130
140
140
130
130
B
HORIZONTAL SCALE

FIG. 5



A
B
40
20
CI=20
C
D

FIG 6

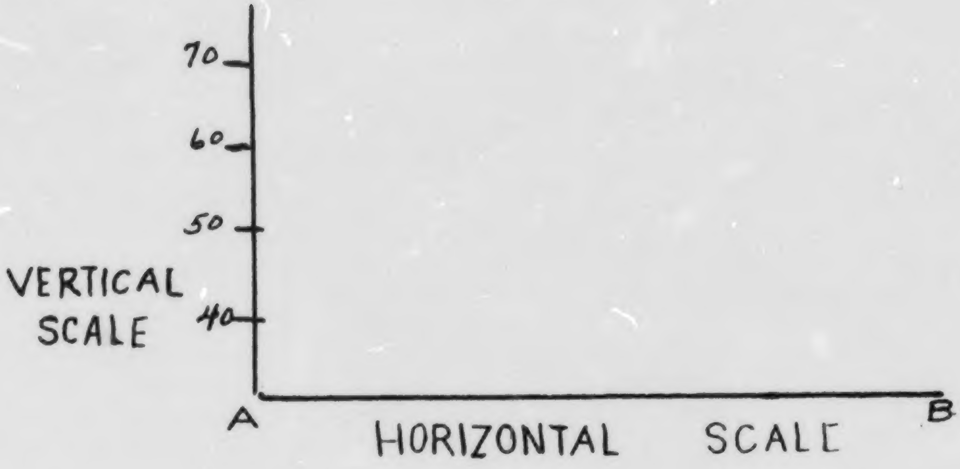

70
60
50
VERTICAL SCALE
40
A
HORIZONTAL SCALE
B

FIG. 7

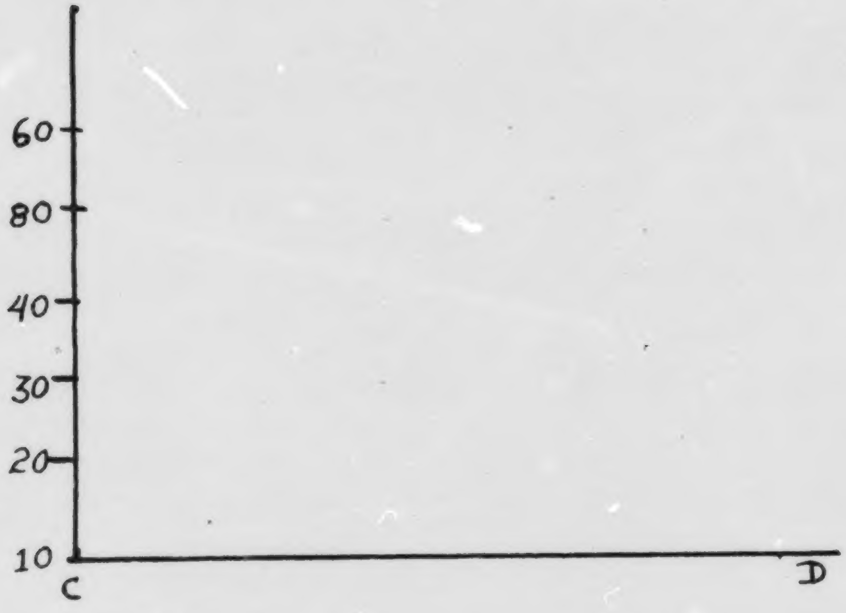

C
D

FIG 8

Problem #4: Hachure Line Interpretation

Interpreting hachure lines can be somewhat confusing depending on how represented on the map. They can be represented as either a depression on a peak or as a depression along a slope. Both cases are illustrated in Figures 9 and 10.

It should be noted that in the case of a depression on a peak the hachure line has the same elevation as the nonhachure line preceding it. In the depression along the slope the first hachure line has the same value as the nonhachure line on the downslope side. If time is taken to carefully construct a profile across AB and CD (Figures 9 and 10) the interpretation becomes much clearer.

From Figure 10 interpret the following elevations:

A ____________________ B ____________________ C ____________________

D ____________________ E ____________________

Problem #5: Construction of Contour Map from Given Elevations

The problem involves constructing contour lines when elevations are given.

In this problem we assume between any two consecutive points of different elevation a slope exists. Furthermore, only those contour lines that fall along that slope may be represented between the two points. An exception exists in the case of a valley (trough) or peak.

On Figure 10 construct the 50, 60, 70, 80, 90 and 100 foot contour lines.

Problem #6: Becoming Familiar with USGS (U.S.Geological Survey) Topographic Maps

Examine a topographic map prepared by the U. S. Geological Survey of an area nearby. Give the following information:

1. Number of minutes latitude and longitude covered.

2. Magnetic declination.

3. Date prepared.

4. How data for map was obtained.

5. Contour interval.

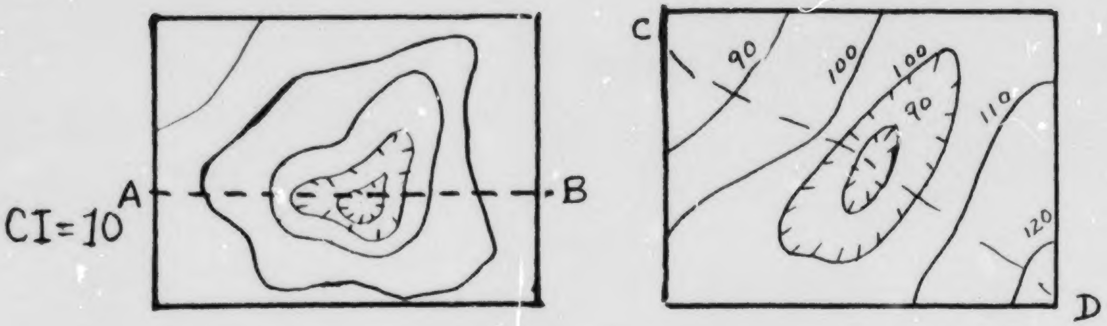

CI=10
A
B
C
90
100
100
90
110
120
D

FIG 9 + 10 HACHURE LINE INTERPRETATION

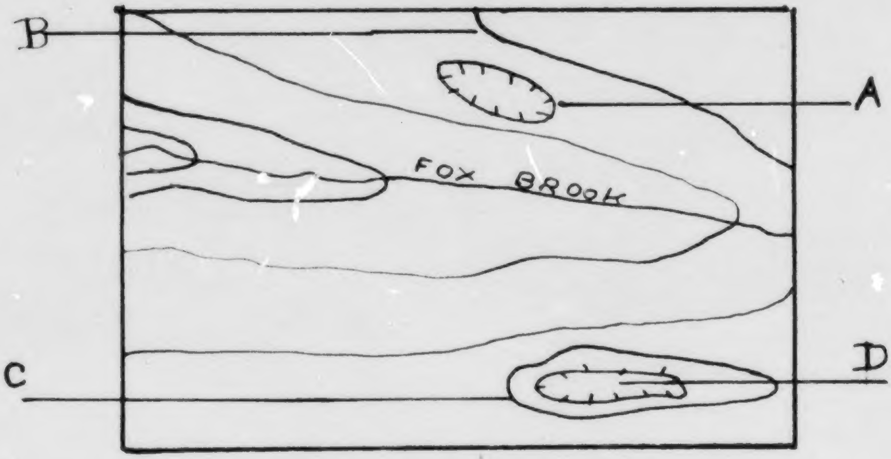
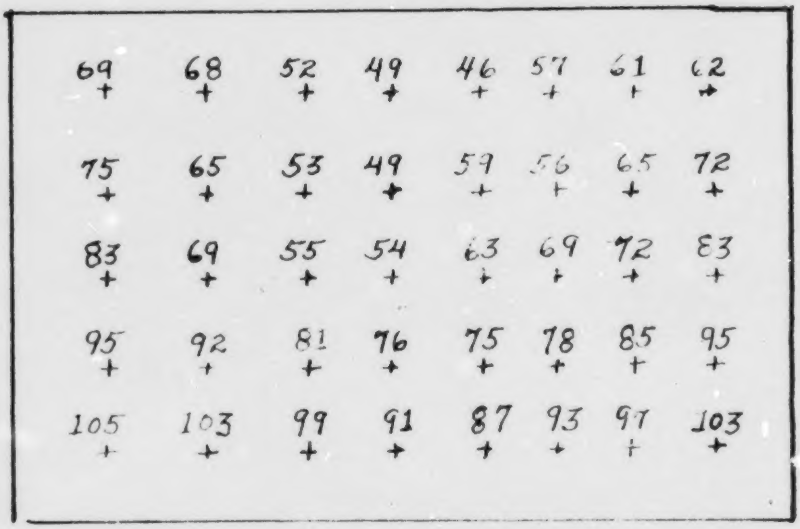

B
A
FOX BROOK
C
D

FIG. 11 CI = 10



69	68	52	49	46	57	61	62
75	65	53	49	59	56	65	72
83	69	55	54	63	69	72	83
95	92	81	76	75	78	85	95
105	103	99	91	87	93	97	103

FIG 12

6. Highest and lowest points represented on the map.

7. Direction of flow of at least 4 rivers.

8. Horizontal distance between two points by use of graphic scale. Give answer in both feet, miles, and meters.

9. Locate as many positions of man-made features and symbols used to designate them. A chart giving these features is given in Figure 11.

10. Elevation and location of at least 5 peaks.

MAP MAKING AND MAP READING

One of the most useful tools that a field biologist or ecologist has at his disposal is the ability to construct a topographic map of a given area he wishes to study. This area may be a body of water, a stream, a river or a parcel of land; it does not matter; the procedures are still the same. For clarity's sake the pond will be used as an example.

Materials Needed

1 3' X 3' X 1/2" plywood table with legs or a folding card table
1 small horizontal level, carpenter's type
1 pocket compass
1 straight meter stick
1 pencil with eraser
1 piece of paper, meat wrapping type (available from delicatessen departments in grocery stores)
1 tape measure or string, measured and marked off in meters

Miscellaneous: Stakes, made from broomsticks or straight young saplings (approximately 4' tall). The number varies depending upon area to be mapped.

Procedures

1. Measure a base line. This is your reference line for the entire map. It has to be a straight line. If you are measuring a pond or a body of water, the base line should be such that at either end of the line the entire shore can be seen. (See Fig. A).

2. Designate each end of the base line as points A and B respectively. Record distance between points A and B and note on paper.

3. Place wooden stakes around periphery of pond. (See Fig. B). The greater the number of stakes the more accurate and meaningful the map will be.

4. Place wooden table with paper attached on ground at point A and level. On paper designate a suitable distance as base line A-B. That is, if the original base line is 150 meters the map's base line could be a distance of 30 centimeters. In this case, the map's scale would be 1 centimeter equal to a distance of 5 meters. Also, align the map's base line by sighting points A-B on the paper with points A-B on the ground. This can be done more accurately with a meter stick.

5. Place the meter stick on the table at point A and line up with the other points along the periphery of the pond. Draw a line on the paper from these points to point A.

6. Position the wooden table on ground at point B and level. Realign map's base line with the base line on the ground by resighting.

19

Fig. A

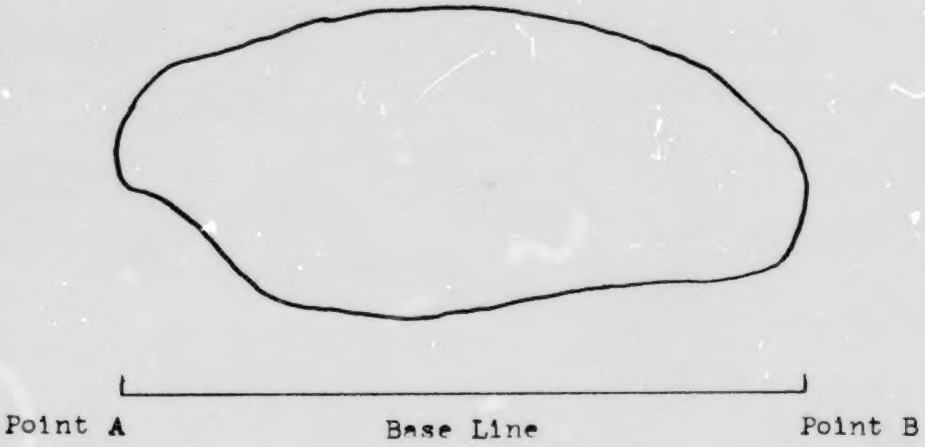
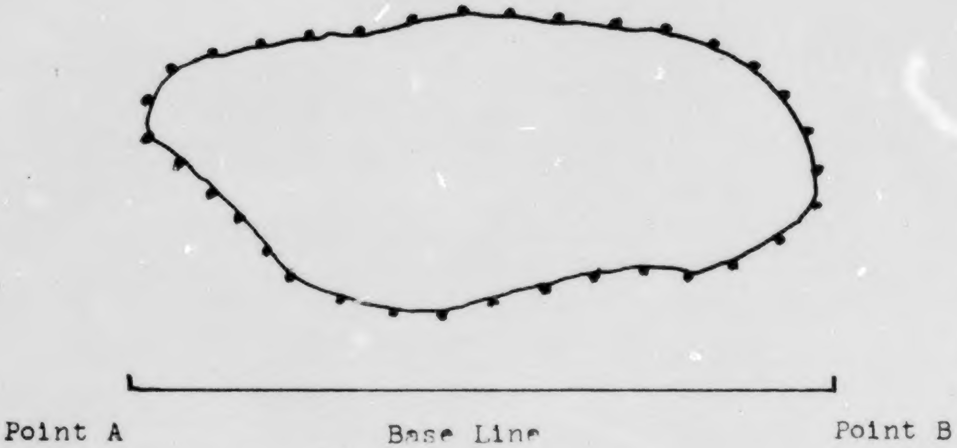

Point A
Base Line
Point B

Fig. B

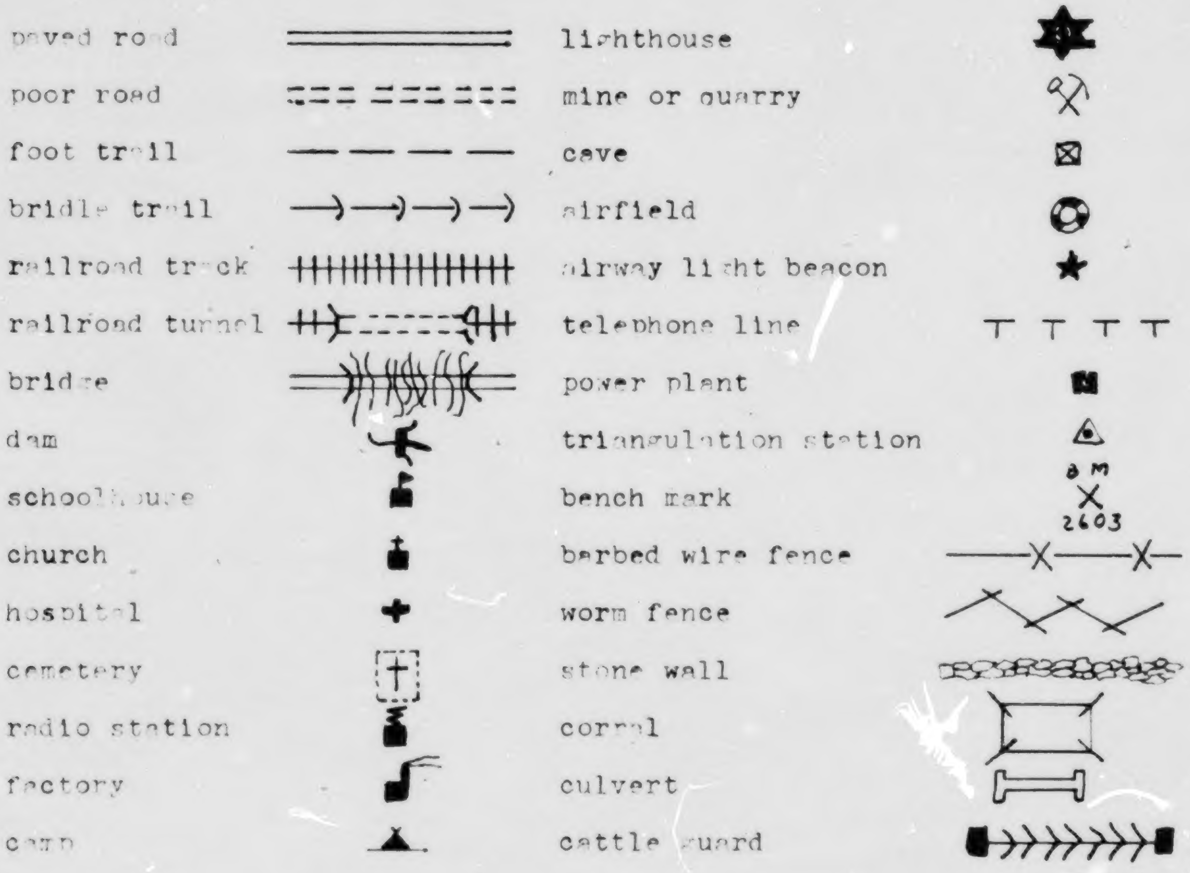

Point A
Base Line
Point B

7. Repeat step 5 but substitute point B for point A.

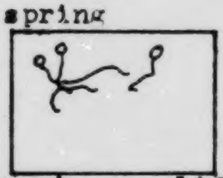
8. When all the points have been coordinated erase the penciled-in lines and connect the points. Remember, the accuracy of your map will depend upon how many stakes were originally laid out.

9. To indicate direction on your map a compass should be placed upon it and a line indicating North should be drawn in the direction of pointer. The map can now be filled in with such items as marshes, swamps, beaches, bottom conditions and pond depth.

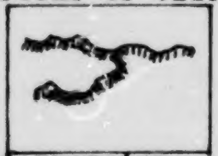
The following is a list of symbols which may be used to indicate various items on your topographic map. The list is by no means complete. Good sources for additional symbols are the sheet "Standard Symbols", published by the U.S.G.S., and the book Topographic Symbols, published by the Department of the Army.


paved road
poor road
foot trail
bridle trail
railroad track
railroad tunnel
bridge
dam
schoolhouse
church
hospital
cemetery
radio station
factory
camp
lighthouse
mine or quarry
cave
airfield
airway light beacon
telephone line
power plant
triangulation station
bench mark
BM
2603
barbed wire fence
worm fence
stone wall
corral
culvert
cattle guard

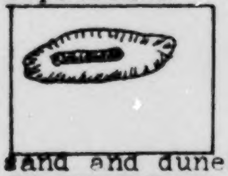
spring



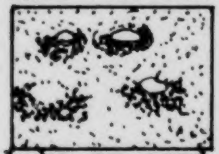
rocks or cliffs



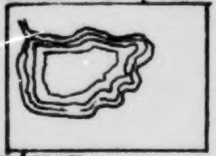
depression



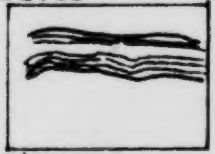
sand and dunes



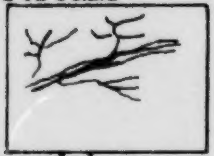
lake or pond



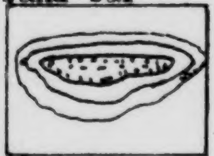
river



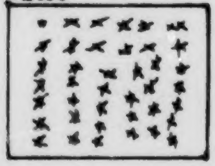
streams



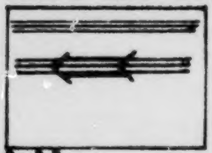
sand bar



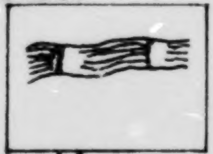
pine



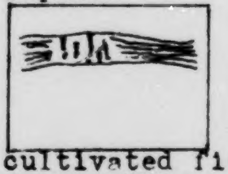
canal and lock



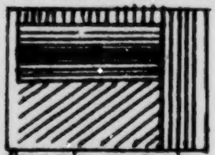
falls



rapids



cultivated fields



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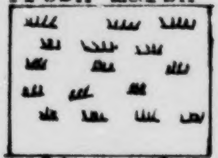

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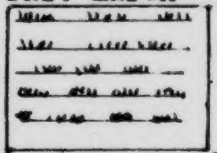

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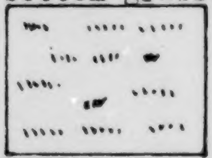
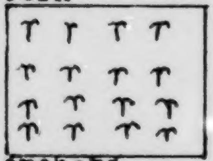
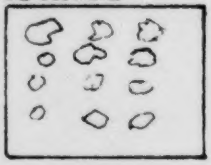


corn



orchard



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III

FIELD TECHNIQUES

A. Preparing Maps for Field Use

Prior to taking a field trip a necessary part of preparation usually involves securing maps of the area of study. Contour maps prepared by the United States Geological Survey provide much necessary information for area studies. These maps are usually in 15 minutes series; however, some areas have been completed in 7½ minutes series.

Maps printed on paper become faded, bleached, tattered and torn with continued field use. A proven procedure for increasing their longevity is given below.

The procedure outlined is for use with U.S.Geological Survey, 15 minutes or 7½ minutes series. However, its application can be used to back other useful maps necessary in field work. Such maps might include state and county surfical and soil maps. Obviously, the map used depend largely on the nature of field work being carried out.

Procedure for Map Preparation

1. On either 15 or 7½ minute series, locate crosses (+) on topographic sheet which divides map into nine sections.
2. Using hard pencil and straight-edge lightly draw lines dividing map into nine sections. NOTE: On some USGS maps this subdivision is already printed on the map.
3. With scissors cut out all nine sections. Save all marginal data for possible later use.
4. Take piece of hardboard or other suitable material large enough to cover map and stretch evenly unbleached muslin over entire board. This material can be held in place by using masking tape. NOTE: Hard desk surface, if available, may be used in place of hardboard.
5. Prepare a mixture of water resin glue (Weldwood water resin glue gives suitable results). This mixture must have a consistency with good flow but not too watery.
6. Apply glue with wood coffee stirrer or popsicle stick. Apply over an area large enough to cover entire map. Be sure glue is applied sparingly so that bubbles won't develop later on.

7. Apply sections to muslin section-by-section with enough pressure to allow excessive glue to move to the sides. Allow a 3/32" gap between each section. This gap is necessary to allow sections to be folded after drying.

8. Allow material to dry overnight.

9. Carefully remove muslin from backing material. Care must be used at this stage or map can rip.

10. Cur around perimeter with scissors.

11. Fold map so all sections are arranged behind front section. Front cover should be back of one section. The back cover should be back side of map section.

12. Cut and glue any information desired for front from marginal strip. Such data might include quandragle name, date magnetic declination, graph scale, and contour interval.

13. After drying, our map is ready for field use.

In this form a particular section under study can be folded to the top. The glue-muslin combination provides a stiffness which prevents any portions of map from bending. The 3/32" gap (usually estimated) provides adequate spacing for folding all sections of map.

Another method used with some degree of success is the application of an acetate adhesive to each section allowing appropriate gaps for folding sections.

B. Pace and Compass for Location Within Map Boundaries

Once we begin studying a field problem located somewhere within map boundaries it becomes necessary for us to locate its position on a map. One method employed involves carrying out fieldwork along a series of carefully paced traverses. Each traverse involves determining direction with a compass and keeping an accurate count of the horizontal distance in that direction. Once pace is equivalent to six feet or 2 steps of three feet along a horizontal plane. Considerable practice must take place before the ability to pace with any degree of accuracy is acquired.

A popular technique used to practice pacing involves placing two markers in the ground three hundred feet apart (300 ft--50 paces). Continually pace between the markers, adjusting paces, until 50 paces is obtained nearly every time.

Next, we would try the pace and compass method along a single traverse of varying elevations and obstacles. Using a map of the area and compass, by knowing our starting point and direction of traverse, we will be able to predict a finish point as well as total distance. How far we deviate from calculated finish as well as calculated distance will determine how successful we are at this stage.

In pacing uphill or downhill a system of compensating for slope must be worked out. We count the horizontal paces along each slope. In compensating along a steep slope, for example, 20 paces along the actual slope could be equivalent to 12 or 15 paces horizontally. On a more gentle slope the number of paces received will be closer to the actual horizontal distance.

Obstacles will often present a problem. Here again, compensations must be made. Such things as thick underbrush, unusually large outcrop, dense vegetation, waterways without adequate crossings, swampy areas, or ponded waters represent just a few of the kinds of obstacles encountered. In compensating, careful attention must be given to how far the obstacle detours us from the original traverse. The number of paces required to follow original traverse through our obstacle is estimated and added to the number at that point. If our detour becomes too great we treat it in itself as a separate "leg" of the traverse.

At this stage we might get the impression that there is a high percentage of error involved with the use of this method. This is generally the case in the beginning but continued practice yields a higher degree of accuracy.

The importance of knowing where we are at a particular point along a traverse cannot be stressed enough. It is necessary, for plotting purposes, in conveying positions of studied features to others. These points can be directly plotted on a printed map utilizing the graphic scale and protracter. The value of an accurate field book giving direction and distance (in paces) of a particular traverse is great indeed. Included also should be the distance along a traverse where features studies are located.

Mention has already been made that a compass is a necessary part of fieldwork of this type. If, however, a standard compass is used, errors can result.

A compass consists of a magnetic needle free to rotate on a pivot point. This needle will align itself in a general north-south direction. Actually, the north seeking end is pointed toward the magnetic north instead of true north. Since these two points are not in the same location, the angle between them, called magnetic declination, varies depending upon the compass location. For example, for locations in Eastern United States true north is east of magnetic north whereas points in Western United States, true north is west of magnetic north. At some points through mid-continent magnetic north and true north coincide. A chart giving declinations in the U.S. is given in Figure 3.

On maps prepared by the USGS true north coincides with a line drawn vertically. Magnetic declination is given in the margin space in degrees east or west of true north. If a traverse is taken along a line 15° west of north and magnetic is 15° west the uncorrected direction from the compass would actually be true north. We find that with an ordinary compass corrections must constantly be applied for magnetic declination.

Where considerable field work is involved the process of constantly correcting becomes somewhat bothersome. An instrument, called a Brunton Compass, is designed to make corrections for declinations. In the Brunton compass the base is rotated so that instead of pointing to zero the pointer points to the value of the magnetic declination in either the eastern or western quadrant of the base. The Brunton compass involves expense and practice beyond that of a regular field compass. However, time saved and accuracy as well as its other applications makes it desirable equipment for fieldwork. A more detailed explanation concerning the use of this instrument is given in the following section.

THE BRUNTON COMPASS

The Brunton Compass was patented in 1894 by D. W. Brunton. Since then over 115,000 of these compact pocket transits have been manufactured and sold around the world.

This compass is used mostly for reconnaissance and preliminary surveying on the surface and underground, for taking topography, and for geological field work. It takes horizontal and vertical angles and can be used as a level or clinometer.

Basically the Brunton Pocket Transit is a magnetic needle set in a case which opens to many sighting arrangements. There is also a vernier for reading vertical angles.

MAGNETIC DECLINATION

The Brunton like any other compass seeks magnetic north. The difference between true (geographic) north and magnetic north varies from place to place. The only place in the United States that true north and magnetic north are the same is along an imaginary line starting in Florida, through Georgia, Tennessee, Kentucky, Indiana and Michigan. (Refer to Isogonic Chart).

The angle between magnetic north, indicated by compass, and true north is called "magnetic declination".

Maps are oriented to true north so when using a map your Brunton should be adjusted for each area of different magnetic declination. Then your readings, from the transit will be the "true" readings of that area.

The magnetic declination can be found on any isogonic chart or if you are using topographic maps the declination of that specific area will be written on the side of the map.

Adjustment of the Brunton for magnetic declination is made by turning the slotted screw on the side of the case. (Refer to diagram of Brunton).

When magnetic declination is east of true north, i.e., you are west of the zero declination line shown on the isogonic map. Rotate the dial clockwise from the "zero pin" on the transit the number of degrees of declination.

When magnetic declination is west of true north, i.e., you are east of the zero declination line shown on the isogonic map (Fig. 3). Rotate the dial counter-clockwise from the "zero pin" on the transit the number of degrees of declination.

Example: for Manchester, New Hampshire, the magnetic declination is 15° west, the needle will point 15° west of true north. Turn the circle so that the zero on the circle moves to the left 15°. Since west on the circle is to the right, the reading of the circle at the "zero pin" will be N 15° W (if graduated in quadrants or 345° if graduated 0-360°. This is the value of the declination. However, if you want magnetic north rather than true north, set the "zero pin" at 0°.

HORIZONTAL ANGLES

We have shown so far how to set the transit and a little about the different tools on the compass. Now we will explain how to take sightings with the Brunton. That is, how to take a bearing on an object and give it a direction.

If the object being sighted is not more than 45° above, nor 15° below the observer the instrument is held waist high with the lid opened toward the operator. The mirror and large sight are inclined so that the tip of the sight and the object sighted can be seen in the mirror simultaneously. When their reflection is seen on the center line of the mirror, and the bubble in the circular level dial is centered, the compass needle indicates the angle.

There are some clues in the handbook that comes with your Brunton that are helpful in obtaining accurate readings:

1. Set the Vernier at zero when taking horizontal angles.
2. Hold arms tightly against body to keep instrument steady.
3. The object should be lined up by rotating the body while holding the hands rigid.
4. Large swings of the needle can be clamped by touching the needle lift pin with the thumb.
5. Small swings can be averaged to get the calculated rest point without waiting for the needle to come to rest.
6. To avoid erratic results be sure there are no steel belt buckles, watch bands, pocket knives, etc., near enough to affect the needle.

If you want to take a horizontal angle on an object more than 15° below the horizontal, use the Brunton as follows: turn the compass so that the mirror-lined cover is turned to face the operator. The sight is taken through the opening in the mirror near the hinge. The large sight is folded so as to be parallel to the mirror cover. In this position the tip of the sight and the mirror center line can be lined up with the object. When the object is observed with the instrument in this position, read the south end of the needle.

VERTICAL ANGLES

Vertical angles are taken by using the vernier that is built into the transit. First the large sight must be extended and the small peep sight at the tip is folded at right angles. The mirrored cover is held at an angle of 45° with the base of the compass. The object is sighted through the peep sight and the hole in the mirror while the fingers of the right hand move the vernier until the bubble in the long level is centered. Open cover and read vernier directly.

It is also possible to take a slope angle by placing transit directly on the slanted surface, and reading the vernier. This is less accurate however, because of the extremely short distance the instrument is in contact with the slope.

AN IMPORTANT FACT ABOUT THE BRUNTON

The E and W on the Brunton are reversed so as to read the compass directly from the face of the instrument. This is different from a regular compass so when used as a "path finder" care must be taken to remember it is not a "Boy Scout" compass.

The Brunton can not only be used as an instrument to get "out of the woods", but it can also be used for an extremely wide variety of tasks. We have shown so far the different tools on the compass and some of the tasks they perform. We will go on now to show the many ways in which field mappers and anyone interested in the environment can use this compass.

To take the strike, or altitude (Fig. 4), of a bed or outcrop of rocks, or to take the strike of any line or series of objects simply hold compass so that line through mirror across the compass from S to N, on to the long sight, are parallel to the object of which you want an altitude. The needle will seek magnetic north then you read directly off the face of the compass. If the instrument is in a position as in Fig. 2, and one is looking in the direction of the arrow, the north end of the needle, being the nearest end to this line of sight should be noted first. Next should appear the angle or number of degrees between the needle and the required direction, and finally is written the direction in which this angle was measured from the needle end. If the angle is 25°, the strike is N 25° W.

We've shown how to take the vertical angles of slopes; this can be used to determine the dip or slope of any outcrop of which you have taken strike. If the strike is North-south then the dip will be either east or west. If the strike is N 50° the dip may be northwestward or southeastward. It is necessary to give only the quadrant in which the dip lies, for the exact direction can be determined from the strike, since the direction of dip is always perpendicular to the strike. (Fig. 4).

The Brunton Compass is an extremely versatile instrument for the scientist working in the environment. The Geologist takes the altitude of a rock outcrop; the Hydrologist gets an altitude on a river; the Forester uses it for rough surveying of roads; the Hiker uses it to get a bearing on his position; the Camper can even use the mirror to shave by in the morning.

A versatile compass should be considered by anyone thinking of buying a good compass. Any fine compass will cost money and for the small amount more than a regular compass, a Brunton may be purchased.

EXERCISE #1

1. By using the isogonic chart (Fig. 3) set your Brunton Compass to the proper declination if you were at the point where Utah, Colorado, Arizona, and New Mexico meet.

2. Chicago, Illinois.

3. Manchester, New Hampshire

EXERCISE #2

This is to obtain a very rough estimate of the height of a mountain.

1. With your Brunton Compass take a vertical angle reading to the top of the mountain. The closer you are to the ground the more accurate.

2. Pace your distance to the top of the mountain. (Measure your paces).

3. Trigonometrically figure out height as in diagram.

4. Try it on a hill with actual measurements.

5. Using a contour map find the horizontal distance. Trigonometrically determine the height of the hill or mountain peak. Using elevation given on contour map, determine how accurate.

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THE BRUNTON COMPASS

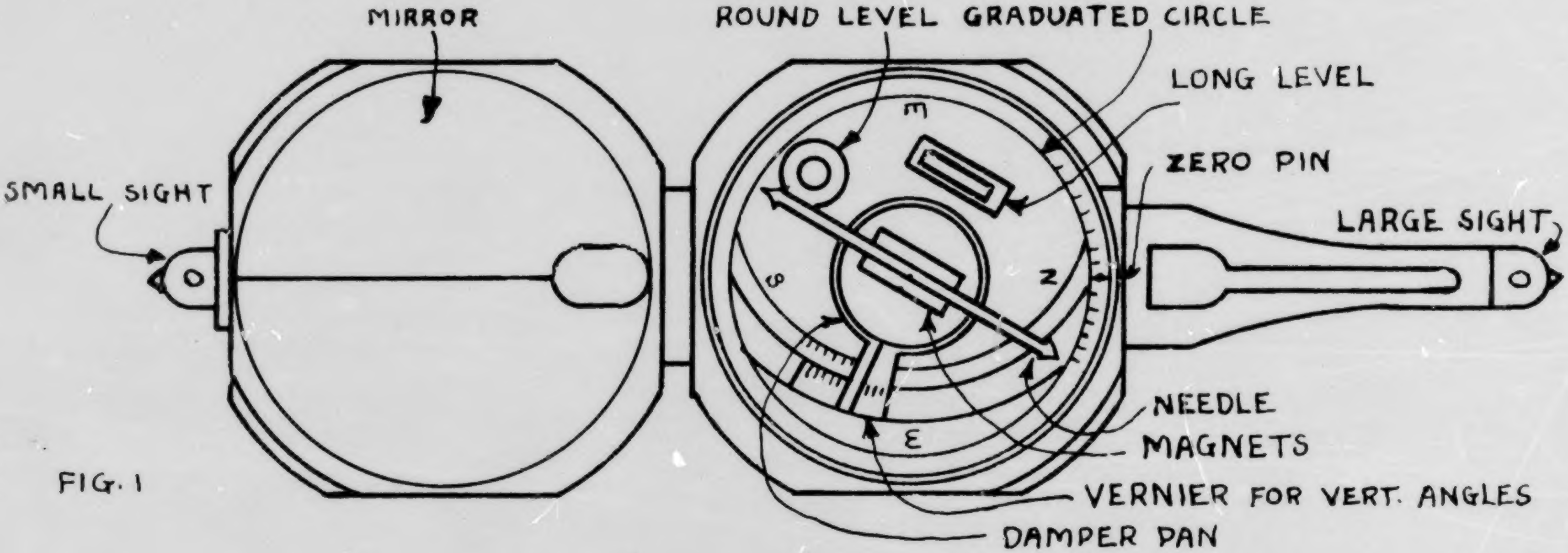

MIRROR
ROUND LEVEL
GRADUATED CIRCLE
LONG LEVEL
ZERO PIN
SMALL SIGHT
LARGE SIGHT
NEEDLE
MAGNETS
VERNIER FOR VERT. ANGLES
DAMPER PAN
N
S
E
W

FIG. 1

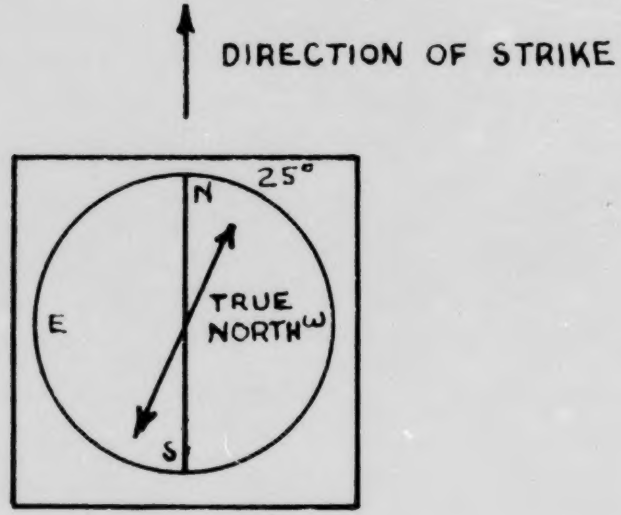
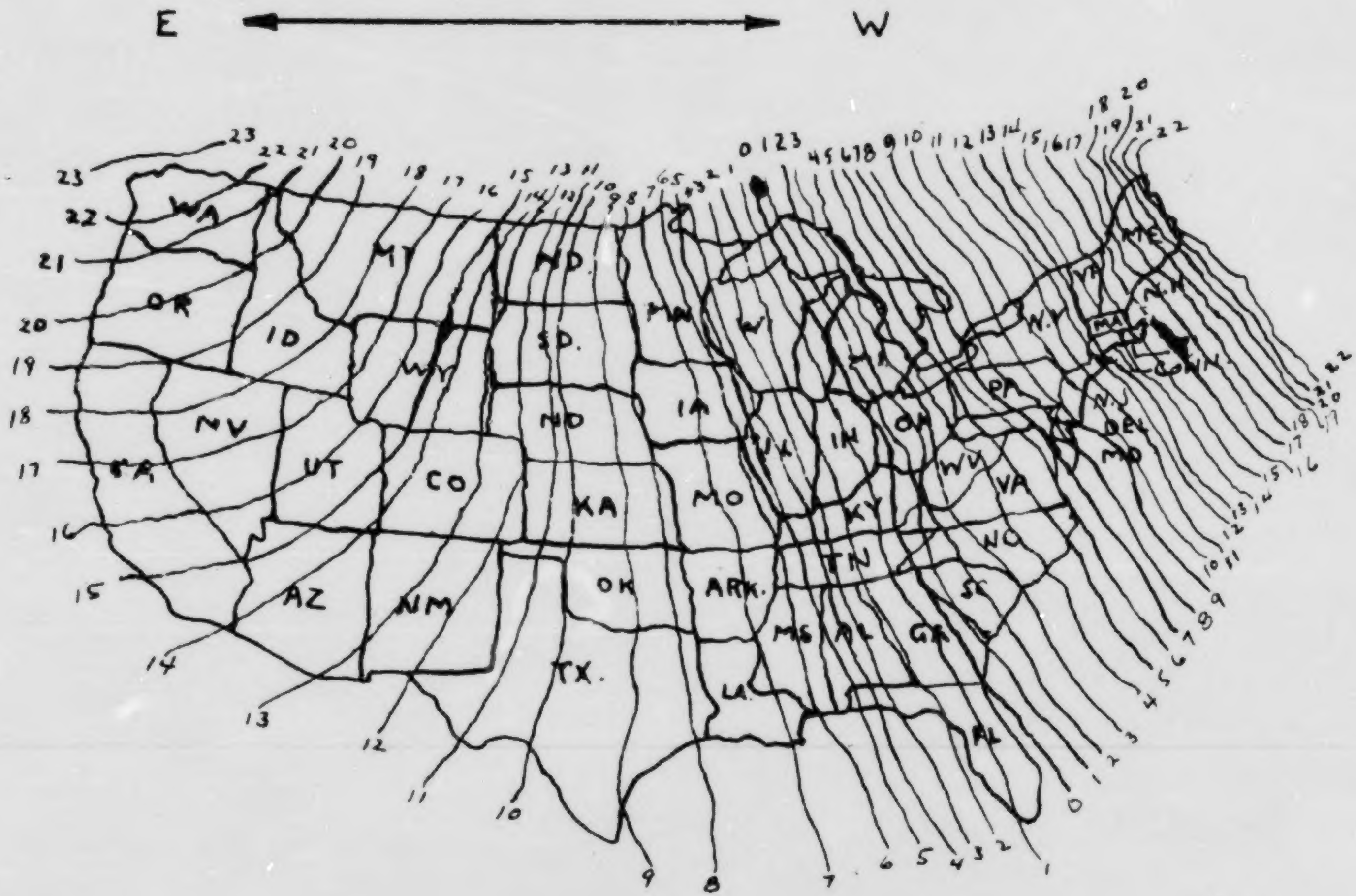

DIRECTION OF STRIKE
N
25°
E
TRUE NORTH
W
S

FIG. 2

DECLINATION MAP


E
W
WA
OR
CA
ID
NV
MT
WY
UT
AZ
CO
NM
ND
SD
NB
KA
OK
TX.
MN
IA
MO
ARK.
LA.
W
ILL
IN
MI
OH
KY
TN
MS
AL
GA
FL
SC
NC
VA
WV
MD
DEL
N.J
PA
N.Y
VT
N.H
ME
MASS
CONN
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ISOGONIC CHART

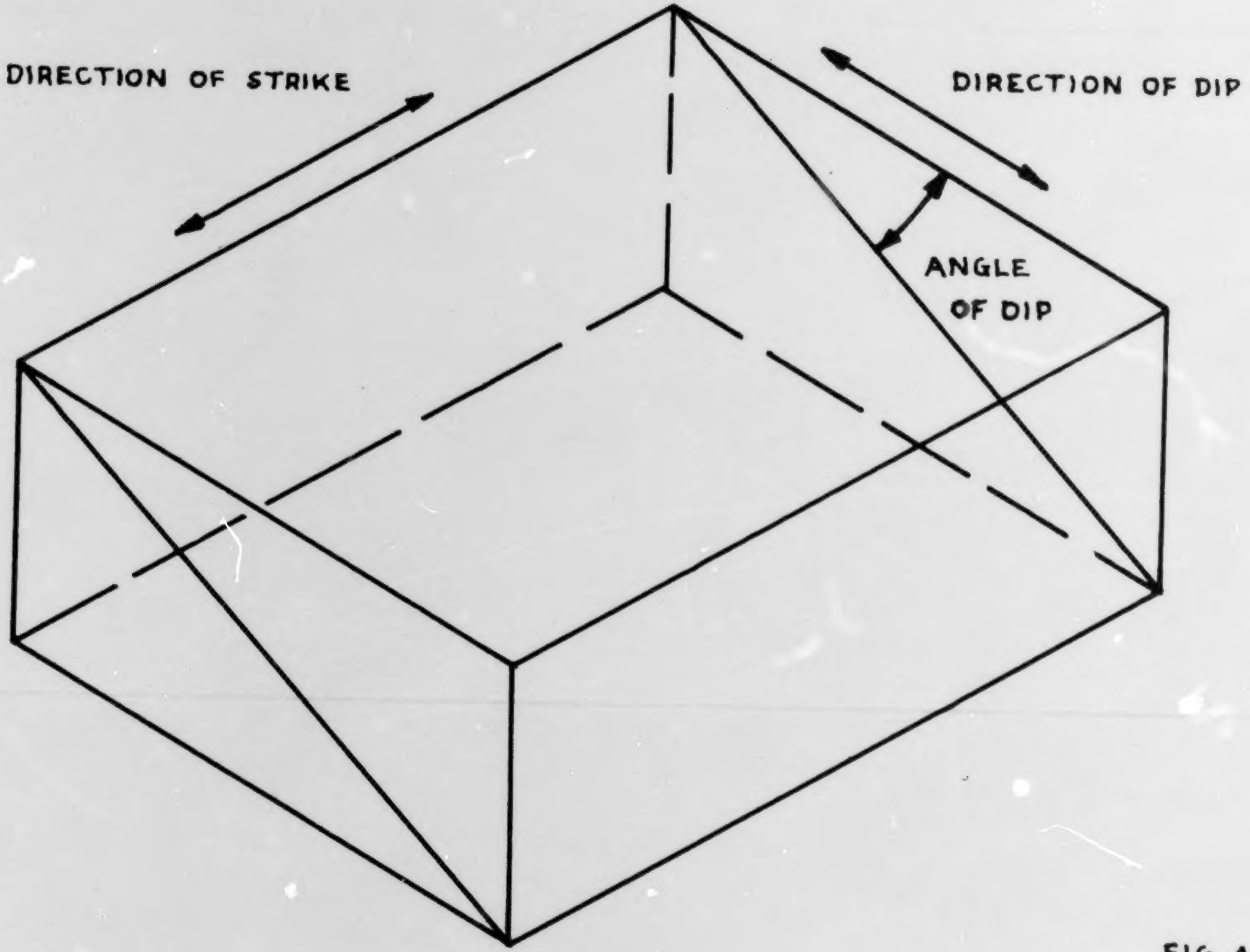
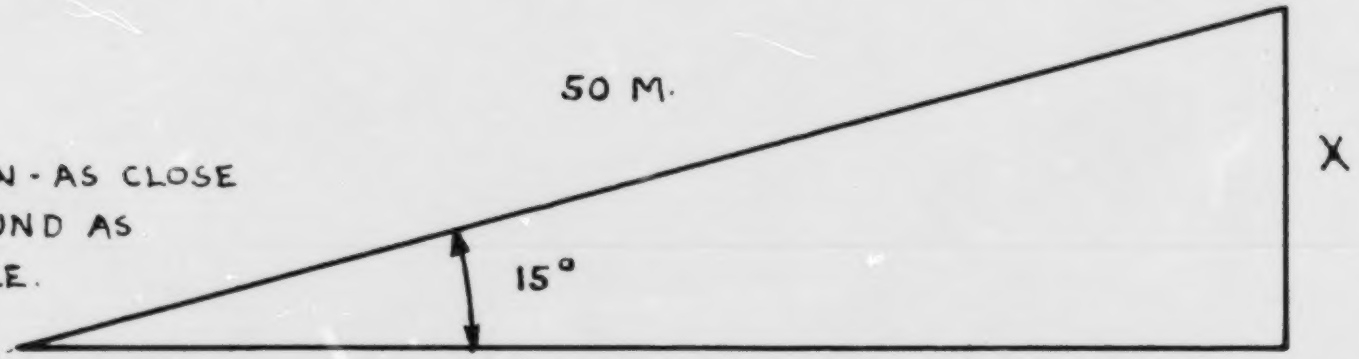

DIRECTION OF STRIKE
DIRECTION OF DIP
ANGLE OF DIP

FIG. 4

EXERCISE NO. 2



BRUNTON - AS CLOSE TO GROUND AS POSSIBLE.

$$\sin 15^\circ = \frac{X}{50}$$

$$.259 = \frac{X}{50} \qquad 50(.259) = 12.95\text{ M.}$$

IV

THE FOREST ECOSYSTEM AND USE OF FORESTS AND PARKS IN ENVIRONMENTAL EDUCATION

The woodlands between our oceanic shores once covered more than half the acreage of the country. The rest of the land, especially in the central and central western states was covered with plains, prairies and an arid desert. As the population of our country increased and the nation grew, expansion took place and along with it the destruction of our forest biome. Forests were once thought of as areas to be cleared or to be utilized and their products put to use for the good of the nation. The very abundance, the magnitude of this country's resources bred a spirit of uncommon, of mere acceptance, of almost contempt of its wealth. We have been, and to a degree, continue to be, as economist John Galbraith put it: "...guided in part by ideas that are relevant to another world, and as a result we do many things that are unnecessary, some that are unwise, and a few that are insane."[1]

Only in recent years is man beginning to realize that he must live in harmony with nature; that our resources have more than just monetary value in the competitive market; that the supply of our resources for the near future is in danger; that even the most modern technology cannot replenish natural resources that have been destroyed and/or depleted. We have to work to conserve and preserve what resources we have left; to improve the sickened condition which we have brought upon our environment; to administer conservation programs and better management to increase those resources which are renewable or perpetual.

Of the 2.3 billion acres of land in the United States, more than half was once covered with woodland, as stated earlier. Today, there are approximately 775 million acres of forest land left in this country. This tremendous amount of woodlands, however, has to be many things to many people. Our nation's forests are depended upon for watershed protection, timber, wildlife habitat, recreation, and in some instances, forage. These demands upon our forests are increasing every year, especially with the growing interest in outdoor recreation coupled with increased amounts of leisure time in our society.

The forests just mentioned have long continued to provide us with valuable by-products besides timber, some of which were mentioned previously. Some of these are pulpwood, distillation products, tannic acid, and maple sugar. Forests are also important in water supply regulation, prevention of soil loss, and climate control. Some of the conservation techniques which are practiced by foresters today include managing forests for sustained yield. This simply means that forests are grown as crops and harvested at regular intervals. In block cutting, whole tracts of similarly aged trees are cut down. Surrounding areas, however, are untouched and the cut-down region is reforested. Strip cutting is a modification of block cutting. In this instance long rows of trees are cut down and replanted. The surrounding countryside remains untouched.

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[1] John Kenneth Galbraith, The Affluent Society. New York, Houghton Mifflin Company, 1957, p. 3.

Without question, fire protection remains the fundamental forestry requirement. Unless it be provided first, every other effort becomes a bad risk. Precaution and prompt detection are the most important and most effective firefighting tools we have at our disposal.

Other conservation methods which are beneficial to forests are selective cutting, sustained yield management, pest control, and silviculture, the science and practice of growing trees as a crop.

Another use or function of our forests which very little has been written about as discussed is their use for educational purposes; outdoor education, environmental education, and cultural inspiration. It is this one point that I wish to expound upon and it is this aspect with which the remainder of this unit will deal. The term "forests" need not limit our thinking to our wooded wilderness areas only. Forests include both private and public owned land. We do not wish to mistakenly limit our use of the out-of-doors as an educational institution to this broad term, "forest". Included in this should be park areas (national, state, county, city, and town parks), wildlife preserves, forest preserves, recreation areas, seashores, lakeshores, community open-areas, and school-owned land.

Before anything can be done with regards to cleaning up our environment, conserving and preserving our natural resources, or replenishing our perpetual resources, data must be collected from these natural areas. Hundreds of scientific tests must be performed to collect this data. This allows for a tremendous educational experience for students. Many of these tests are simple, and materials inexpensive, so that even grammar school students could gain a lot from out-door visits by a class. Field trips are an integral part of the education planning a teacher must make for the growth and development of the children in her classroom. Field studies, trips, visits, and investigations are extensions of classroom teaching. These field trips can be visiting trips, collection trips or field investigations. Many schools have easy access to state parks, or at least a city or town park. Some schools are fortunate enough to be located close enough to a national park or national forest area. The National Park System, National Forest System, State, County, and City Parks are the largest and most generously endowed campuses without walls. Ironically, and unfortunately, they are the most under-used areas for educational purposes at the very time they are needed to serve the increasing needs of educational innovation.

Our system of parks, forests, and wildlife areas do not have to become an educational and cultural institution; they already are one. Their roles in the fields of recreation, preservation, and conservation have overshadowed their potential as a classroom. It is up to the alert teacher to realize this potential and to take full advantage of Mother Nature's gifts. These "generously endowed campuses without walls" are too valuable an educational tool to remain unused for educational purposes. The remainder of this chapter will deal with ideas to make use of our environment as a classroom; tests which can be made to increase one's knowledge of the environment and to foster an interest in young minds towards the value of our natural resources.

Visiting Trips

Visiting trips usually involve traveling to a field site and taking a tour of the area or facility with the specific goal of seeking information on a firsthand basis through observing and asking an authority to explain and interpret what one sees. This visit adds dimension and reality to the learning experience and provide total sensory experience involving sight, hearing, smell, touch and sometimes even taste. Visiting trips may or may not involve a resource person. The teacher may act as the resource person on some trips. The following are some examples of places that a classroom could visit for environmental education.

...Another resource available is a county or state park. In New Hampshire, for example, there are several state parks within easy traveling distance from Manchester which would make a day visit to such an area a relatively easy and rewarding venture. State park personnel will be more than happy to assist you with your visit and answer questions which you or your students may ask. Many of the same features would be observed in state parks as could be seen in national parks.

...If there is a lumbering company or paper company in your area, there is a possibility that they may be willing to give a tour through one of their forest areas. Most often, the conservation practices administered by such companies far exceed the standards followed by the National Park Service and National Forest Service. These companies are actually doing more than their share to conserve these resources for the future of the company depends upon them. A company forest management personnel will more than likely be available to assist you in the trip and act as a guide and information source. He can identify the various species of trees and plants, explain lumbering and conservation practices, and give an overview of the forest ecosystem. He could probably demonstrate planting techniques and give a lecture on silviculture.

Collection Trips

Collection trips involve more planning and preparation than do visiting trips. Collection trips, however, are available to any school because a National Park, National Forest, State Park, lumber company, etc., are not necessary criteria for such a trip. Resource personnel are not necessary and the visit can be made to a forest, a pond, the seashore, a playground, a city park, a gravel pit, or almost any outdoor area within easy access by the school.

Collections made during a collection trip can be brought back to the classroom for further observation and investigation. To make collections successful, collection equipment must be considered. These need not be expensive or complicated and much of the equipment can be homemade. An earlier publication put out by St. Anselm's College and Manchester Public Schools is entitled Student-Made Environmental Studies Equipment, and is available from:

Environmental Studies Program
Office of Federal Affairs
St. Anselm's College
Manchester, New Hampshire 03102

In this publication, several types of collection equipment are described and instructions for their construction and use are given. Some of these are a soil sample holder, water sample collecting equipment, dredges for bottom sampling in rivers and lakes, Plankton nets, vasculums, and plant presses. Some types of collection do not need any special equipment.

A listing of collections that can be done during field trips is included in the activities section.

A. Suggested Activities

1. Succession Studies

   a. Area subjected to forest fire

      1. Test soil samples to see the degree of variance from an area unaffected by fire
      2. Examine plant species just developing
      3. Examine stumps and remains in order to compare the type of forest presently developing with previous forest
      4. Test soil for pH, potassium and phosphate content using soil kits
      5. Consult other references concerning:

...How fire can be a beneficial and ecological factor
...Fire as a decomposer--considered part of a normal process
...Consider succession with fires, ponds, and blowdowns--which are must abundant
...Fire as a seed dispersal agent
...Fire as a producer of diversity--a land management tool

b. Examine an Area Surrounding a Lake's Edge

1. What kinds of plants dominate from the lake's edge to forest. Make a sketch using a graphic scale and listing the different species

2. Observe a log at water's edge. Search for mosses. (This marks the beginning of succession)

3. Examine soil cover below plants

4. Search for cranberries, leatherleaf, blueberries, and larch

5. Locate trees with base in water, such as alders

6. Find cattails, rushes, and water lilies

7. Look for possible original boundaries if lake or pond. A topographic map might be of help

c. Examine the Area Below a Power Line

1. Compare areas which have been recently sprayed with those where a number of years have past since treatment

   a. What species survived the spraying?

   b. What happens as defoilates fade with time?

2. Observe an ecotone in miniature--(forest edge)

3. Power lines represent a good location to provide adequate space for the class

4. Study of ant hills and forest litter

d. Compilation of Tree Data

If diameters and height are known, formulas can be obtained in forestry references to determine the age of the tree without actually making a cut. A cloth tape can be used to determine a tree circumference. Once this is determined the formula $C = \pi D$ can be used to obtain the diameter. The height can be determined either by using a Brunton Compass (described in the Field Techniques Section) or a simple Isoceles triangle can be constructed out of cardboard or wood to sight to the top of the tree along the hypotinuse. By measuring the distance from the base of the tree to the location of the observer the height of the tree is determined--diagram and discuss with students why this can be done.

e. The teacher might give some consideration to the use of National Forest and Recreation areas for developing printed field guides for students and teachers. These can be expanded from year to year. One advantage is that these areas are not likely to be a part of the urban sprawl and access can always be obtained.

f. Provide students with occupational information in the National Forest System or related recreational areas. Emphasis has been given to more free time and expansion of services--this expansion will create more jobs.

B. SECONDARY SUCCESSION

Throughout the United States and especially in the eastern states, undisturbed plant communities are very rare. In the eastern and Central states most forest communities have either been cut, burned or suffered some other calamity such as flooding or wind damage. Ecologists are, therefore, often confronted with the problem of reconstructing the "natural vegetation" from plant materials which are left rather than sampling mature virgin communities. It is possible, when measuring a disturbed stand, to reconstruct the previous stand of vegetation as well as determining what caused the disturbance. In completely harvested forests for example, a great deal of information can be obtained from existing stumps. This information includes the age of the tree at time of cutting; growth rates, including periods of suppression and periods of unfavorable weather conditions; dates at which fire occured; sprouting ability at different ages; and species--pioneer or climax.

Method

Sample the stand using the aforementioned Quadrat Method and record all information on data sheets. In addition to this, record the following data, if available:

1. Stumps: Age, basal area, species (use a key to stump woods such as that in Brown and Panshin), dates of slow or fast growth, dates of fire scars, number of sprouts.

2. Trees: Origin (stump sprouts or seedlings), multiple stems (usually an indication of sprout origin. Record the basal area of each stem separately and circle all values that came from the same stump), samplings, age of trees of sprout origin (use increment borer).

Use the information obtained to reconstruct the forest at the time of disturbance. Also, make a prediction as to the possible future of the forest.

Materials

Increment borer.

Hand lens.

C. QUADRAT METHOD OF PLANT COMMUNITY STUDY

The area sampling method is probably the most widely used of all sampling methods. Basically it consists of a square area of known size called a quadrat. Quadrats are distributed at random in a stand to be studied. A quadrat measuring 33' X 33' in size is 1/40 acre.

In each quadrat, all plant types to be examined are recorded on a previously prepared data sheet. In the case of trees, the basal area of each individual tree at a point 4 1/2 feet above the ground is recorded for trees of 12 square inches in basal area or over. For shrubs and saplings, it is usually not necessary to record the number of individuals of each species, while for herbs their mere presence is recorded for each quadrat.

Quadrats must be accurately constructed in the field, according to the following procedure: set a corner stake at the selected point. Lay out a line 9' long and set another stake. Then find a point which is 12' from the first stake and 15' from the second stake. These three points form a right angle triangle. By sighting over the pairs of stakes, it will be possible to establish two sides of the quadrat each of which should be measured accurately to be 33' in length. The other two sides are easily placed by running 33' lines from the new corners. Their point of intersection is the fourth corner.

Whenever possible, 30 or more quadrats should be used in each stand of vegetation. Any lesser number may give misleading results. Trees falling on one of the boundary lines should be counted only if more than one-half of the trunk is within the quadrat. In the case of herbs and shrubs, only those which are rooted within the quadrat should be used.

Sapling and shrub quadrats measure 6.6' on a side and herb and tree seedling quadrats measure 3.3' on a side. A common practice is to locate the smaller herb and shrub quadrats in the corners of the larger tree quadrat.

After a suitable number of quadrats have been examined it will be possible to calculate certain standard measures of vegetation. These are:

1. Frequency--the percentage of quadrats occupied by a given species.

2. Density--the average number of individuals of a species per quadrat, obtained by dividing the total number of individuals of that species in all quadrats by the total number of quadrats examined.

3. Dominance--the average basal area of each species per quadrat. If basal area tapes are not available, the areas may easily be obtained from the circumferences or diameters by use of conversion tables.

In many comparitive studies, where the main emphasis is on the contrast between two or more communities of approximately similar over all density and dominance, better differentiation is frequently obtained by the use of relative rather than absolute values, as follows:

1. Relative frequency--number of occurences of one species as a percentage of the total number of occurences of all species.

2. Relative density--number of individuals of one species as a percentage of the total number of individuals of all species.

3. Relative dominance--total basal area of one species as a percentage of the total basal area of all species.

Each of these relative measures indicates one aspect of the importance of the species in the community, but a better measure is obtained by combining them by summation. This total of the relative frequency, density and dominance is called the Importance Value and should add to 300 for each stand. It is particularly valuable for the tree members of forest stands.

Equipment Needed

50' cloth tapes.

Quadrat corner stakes, painted in alternate stripes of red and white.

Herb or seedling quadrat stakes, each 3.3' long.

Data sheets for community types to be examined.

III. Other Activities

...Organize a field trip to a local pond, stream, or other natural community. Divide the class into teams of 4. Assign each team a specific area (about 3 square feet) to study. Have 2 members of each group list all the types of plants and animals you found in the area. Have the other 2 members of the team observe the animal segment of the community and try to determine their sources of food. The activities of the animals should be recorded.

...Are the animals noted confined to the area you are observing, or do they move in and out of the area?

...What do the animals eat?

...What organisms are the food producers in your area?

...Are these predators? What are they?

...What are some producers and predators you might have missed in your survey?

...How do these organisms depend upon each other for survival?

...How is man dependent upon these organisms?

...In what way does man destroy these organisms?

In two separate field trips, visit a river or stream that appears clear and flows through a sparsely populated area, then visit a stream which is polluted. Likely sources can be found near industrial drainage systems, homes, shopping centers and farms. Take a sample of water from each stream. (If you wish, you may want to take samples of water from a stream before flowing through an industrialized area, and a sample of water from the stream after it has flowed through the same area).

Perform the following tests on both samples:

1. Sediments--allow a jar of each sample to settle for 24 hours. Compare the amounts of solids by measuring the depth of the sediment; or, if you have this equipment, you can filter equal amounts of water from each sample and weigh the trapped sediments.

2. Hydrogen in concentration (pH)--this test determines the acidity, or alkalinity of the water. HACH Kit Model 17-N (wide-range pH test kit) can be used for this test.

3. Temperature--measure the water temperature at various levels of both the polluted and unpolluted streams. Record the data and construct a temperature profile of each stream.

4. Microscopic Life--take water samples at different levels of both streams by using a homemade dissolved oxygen bottle sampler. Examine a drop of water from different types of organisms viewed.

5. Chloride Test--using the HACH Kits--Model 7-P and CD-50 (low and high range chloride kits, respectively) test samples from both streams for salt content. Record the results and compare.

6. Phosphate Test--using HACH Kit #12522-00 (water test cube set). Test both water samples for phosphate content. Record and compare the results.

SAMPLE DATA SHEET

STUMP DATA

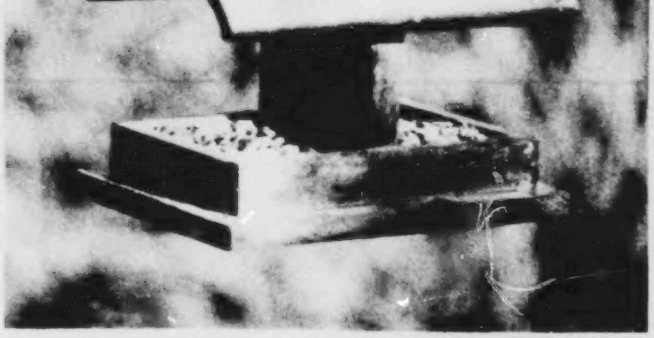
Species	Age	Date of cutting	Date of origin	# of sprouts	Age of sprouts	Dates of fire sears, sup-pression, growth, etc.

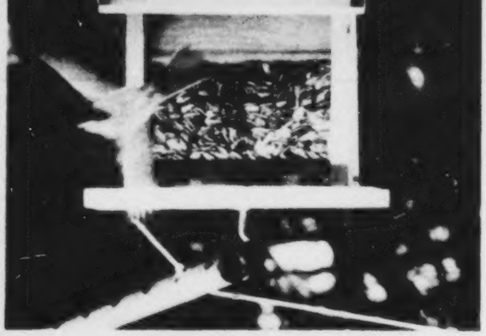
II. General Bank Study

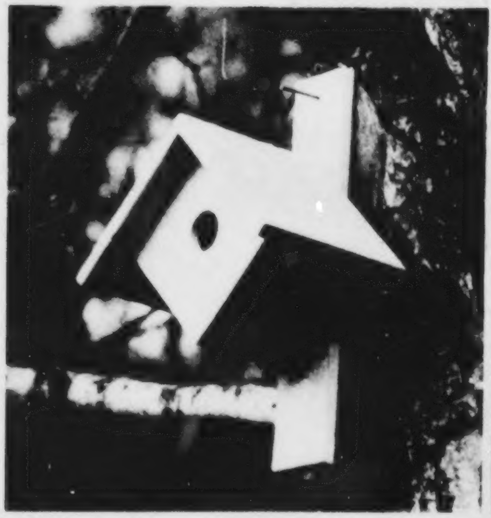
1. Examine soil profile and locate layers and textural differences.
2. How many different rock varieties can be found?
3. What degree of weathering is exhibited by the different varieties?
4. Locate stratification and cross-bedding.
5. Examine the floor of a gravel pit for fungi and lichens.
6. Search for windblown deposits (loess).
7. Examine vertical sections for the presence of bank swallows. Once located a number of interesting studies can be designed by students to study habits and behavorial patterns of these birds.

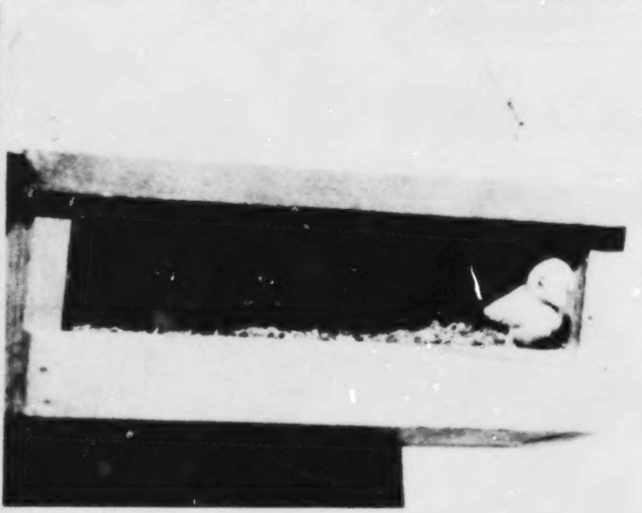
QUADRAT METHOD DATA

	Tree Species										
Quadrat #	SM	Bass	Elm	Iron	RO	Y Bud	BN	Hack	BC	WO	BW
1.											
2.											
3.											
4.											
5.											
6.											
7.											
8.											
9.											
10.											
# Quads											
# Trees											
Total B.A.											









V
THE BIRDS

A.

INTRODUCTION

The birds are the most easily recognized form of animal life. Other than pet animals they are the first forms of animal life we become acquainted with as children. They are the only forms of life that possess feathers.

Of all the animals known to mankind birds are the most cosmopolitan. They are found from the Arctic Circle to the Antarctic. They live at altitudes from sea level to the tops of the highest mountains. Despite the ability of birds to occupy almost any niche in the environment they are specific as to the type of habitat and the geographical range they occupy as species.

Birds have been used by mankind for food and dress. Animals, such as ducks, geese, pigeons, partridge, prairie chickens, ostrich, and auk have been hunted mercilessly by man to the point where some species became extinct. On the other hand some species withstood the ravages of time and became domesticated. Birds such as the domestic duck, goose, chicken, turkey, pheasant, and pigeon all had their origins with wild species.

Many birds are beneficial to mankind in other ways, such as the consumption of harmful insects, the seeds of weeds, small rodents, snakes and dead carion.

The study of birds has long been one of the more enjoyable portions of the nature stroll. In addition to expanding our appreciation of the simplicity and also the complexity and beauty of nature, birds observation has provided us with a healthful exercise. The following pages will try to point out some of the methods which are available for the study and care of birds.

B.

BIRD BLIND

It is often necessary and advisable when studying birds in a particular area to have, so to speak, a base of operation, a place where birds may be observed and not unduly alarmed. Such a place is a bird blind.

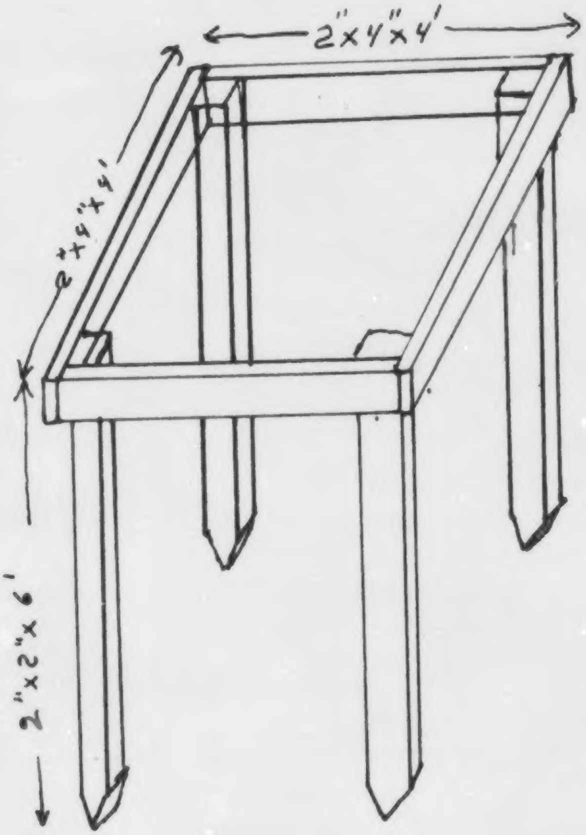
A blind that is durable and can give many seasons of use may be made from scrap lumber, sheet metal (auto body), wood screws, and heavy cloth, such as burlap.

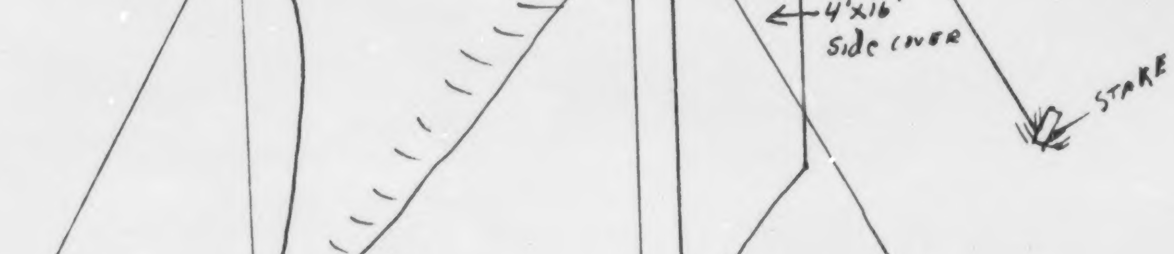
The following dimensions, however, should be maintained: 4' X 4' X 5'. These dimensions give us a blind that is capable of accommodating several students and is still not too cumbersome to carry and erect close to the site of study. In any case, the blind should be assembled in the approximate vicinity but not in its permanent location as this might unduly alert the birds one wishes to study and therefore render the location of the blind useless.

After assembly the blind is left alone in the area for a day or two in order that the birds might become acclimatized to it. If, after two days upon returning to the sight,

BIRD BLIND CONSTRUCTION

DRAWINGS


2"x4"x4'
2"x4"x4'
2"x2"x6'


4'x4' CANVAS OR BURLAP COVER
6' rope
4'x16' side cover
STAKE

it is seen that the birds have accepted it the blind may be moved even closer to its permanent sight. In no case, however, should the blind be any closer than 5 to 6 feet.

Construction Materials

4	pieces 2" X 4" X 4' pine mitered at each end to an angle of 45°.
4	pieces 2" X 2" X 6' pine flat at one end and mitered to a point at the other end.
4	L brackets measuring 4" on each side and 1" wide (made from scrap auto body steel).
4	pieces of rope 6' long--fortifying roof.
4	straps 6" long and 1" wide made from scrap steel.
1	sheet of canvas or burlap 4' sq.--cover.
1	sheet of burlap or canvas 4' X 16', tied on 3 sides with one side as a flap.
32	flat head wood screws 1" long.

C. ELEVATED BIRD BLIND

Because of the varying nesting habits of birds it is often necessary to climb a tree to get a glimpse of the nest of a particular bird. In many cases the reason why some birds are so precariously perched at the top of trees or on small outlying limbs from such trees is to avoid any confrontation or disturbance from unwanted visitors. In such cases it is not recommended to climb an adjacent tree as an accident is likely to occur and the birds will become unduly alarmed.

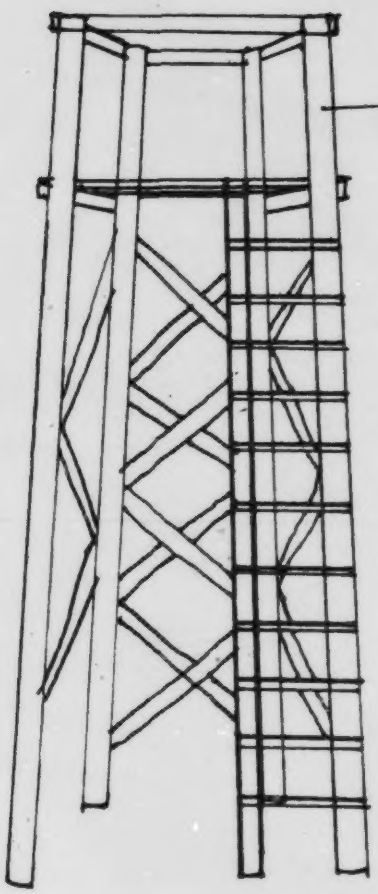
In such instances an elevated bird blind becomes a necessity for the observation of birds. A bird blind with the following dimensions would give the most usage in the woods. The total height of the blind should not exceed 25 feet. The upper portion of the blind should measure 4 feet square whereas the floor of the blind should measure approximately 6 feet square. The blind should be covered with a heavy cloth preferably such as burlap or canvas which has not been dyed.

Precautions to be taken with the elevated bird blind are as follows: 1) the blind should be erected and left in the general area of its final installation point for a few days to enable the birds to become acclimatized to it; 2) after 2 or 3 days the blind can be moved to its final location (a good rule to follow in locating the blind is that the blind should be no closer than 10 feet for a bird 12 inches in length or more and should be no closer than 6 feet for a bird measuring less than 12 inches).

A list of materials needed is included with the drawing on the following page.

ELEVATED BIRD BLIND CONSTRUCTION

DRAWINGS



BLIND AREA ASSEMBLED AS IN GROUND BLIND

TOTAL HEIGHT NOT TO EXCEED 25 FEET

D. BIRD FEEDERS

One of the main reasons for feeding birds throughout the winter months is to maintain a local bird population. This local bird population might want to be maintained for the color it will add to the local environment or for a means to rid the habitat of the unwanted excess in insect pests which might be present in the warmer months.

Depending on the type of birds which frequent a particular locale, their feed will consist of one or more of the four following types: (A) Grain, (B) Suet, (C) Sugar Water, (D) Fruit. In some areas, especially in the Northeast, feeders which contain grain or suet or a combination of both are most successful. It must be remembered that once a feeding station has been established, the birds in the area become dependent upon the statio[illegible]r survival. In winter months feed is very rare and almost nonexistent. Therefore, [illegible]are of feeders is essential. In summer months it is a fallacy not to care for the feeders which one has watched so carefully during the winter months. People are under the mistaken idea that the birds do not require any more feed. In all actuality, to keep birds in a particular area, feed should be available throughout the year. Thus, a bird feeder acts as a stable source of food when other sources in the environment fluctuate so greatly.

On the following pages are drawing of several types of bird feeders which have proven successful. Accompanying each feeder there are instructions as to their construction, care, or particular birds which frequent the feeders.

E. BIRD'S NEST VIEWER

This apparatus is handy for observing the day to day happenings in a nest which is too high above ground to see into, yet is not so high off the ground as to require an elevated bird blind.

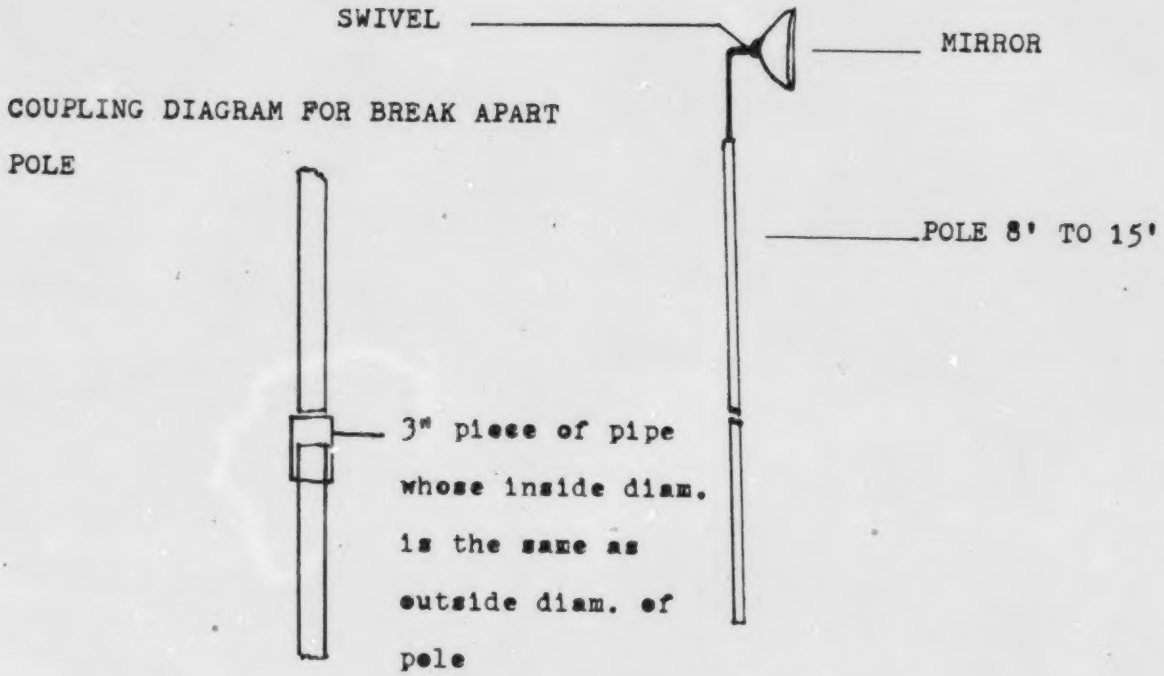
The construction is simple. The materials which are needed can mostly be acquired from a junk yard and a hardware store.

MATERIALS

1 swivel remote side auto mirror--can be obtained from an old auto

1 swivel attachment

1 pole, plastic pipe, or wood dowel (8 to 15 feet in length). Pole can come apart into several pieces in order to facilitate transportation.


SWIVEL
MIRROR
COUPLING DIAGRAM FOR BREAK APART POLE
POLE 8' TO 15'
3" piece of pipe whose inside diam. is the same as outside diam. of pole

F. BIRD NESTS

With the decline of our wooded areas, our large forests, fruit bearing orchards, decaying bogs and swamps, the population of birds for any local habitat has decreased. To combat this loss in nesting territory many organizations such as the 4-H clubs, Boys and Girls Clubs, the Boy Scouts of America and Girl Scouts of America have adopted the practice of constructing and placing bird houses about homes. Manufacturers have gotten on this economic wave in the construction of bird houses. Many of these manufactured homes, however, fall short of the requirements of our feathered friends. The construction of bird houses with the knowledge as to the requirements of the inhabitants seem to be most successful. The following things to remember have been adapted from the BULLETIN of the Massachusetts Audubon Society. In many instances the items noted are common sense and should be kept in mind as requirements for a successful bird home.

The following is a list of items that should be remembered when building bird houses.

1. Build a house for a particular species that is native to the area or that you wish to attract--not just a bird house.

2. Use wood of at least 1/2" thickness; pine, which is dried and free from knots is most desirable.

3. To provide most healthful conditions, ventilate the box just under the roof with with small slits.

4. Provide drainage through holes in the bottom of the box. This will insure the safety of young birds from drowning during a heavy rainstorm.

5. After each breed of birds, the old nest should be removed and the house cleaned. This has the advantage of attracting more birds and also rids the house of parasites which would be harmful to future inhabitants.

6. It is advantageous to have the back of the house extend 2" above and below the house. This extension provides an easy method of attaching the house to objects.

7. For the sake of permanency all hardware that is used in the construction of the house should be of galvanized material, or brass.

8. One family boxes are most successful except in the case of Purple Martins. Birds are territorial and even more so during the mating and nesting seasons, and are not tolerant of members of the same species or of other species in the area.

9. Boxes should be placed in the open rather than in thickets or heavily weeded areas.

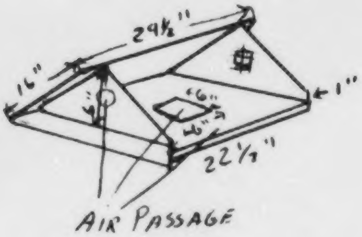
10. Place metallic guards on access routes to the homes to protect the inhabitants from cats and squirrels.

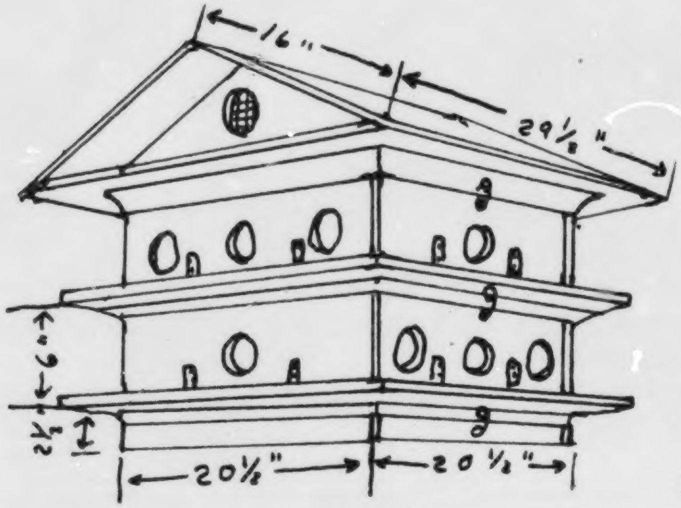
11. Place only 4 to 5 box nests per acre. More boxes will not be occupied. Birds need the territorial room.

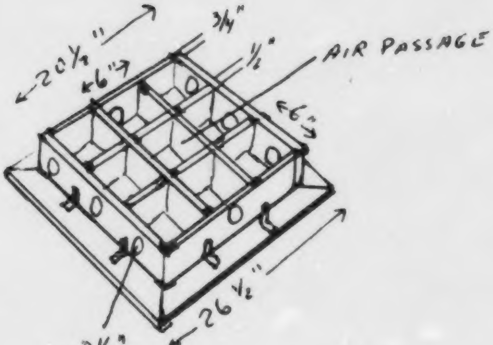
Here, in tabulated form, are some specifications for bird boxes. These specifications cover the species listed and possibly birds of the same families.

BIRD NAME	FLOOR OF CAVITY	DEPTH OF CAVITY	DIAMETER OF HOLE	HOLE ABOVE FLOOR	HEIGHT ABOVE GROUND
Bluebird	4" to 5"	6" to 8"	1 1/2"	5" to 6"	4' to 12'
Tree Swallow	Square				
Robins	Nest on simple shelves 6" to 8" square with an overhang for protection.				
Phoebes	Nest on simple shelves 6" to 8" square with an overhang for protection.				
House Wren	4" square	6" to 8"	1"	4" to 6"	5' to 10'
Crested Flycatcher	6" square	8" to 10"	2"	6" to 8"	8' to 20'
Chickadee	4" square	8" to 10"	1 1/4"	6" to 8"	8' to 15'
White-breasted Nuthatch					
Downy Woodpecker					
Flicker	7" square	16" to 18"	3 1/4"	11" to 13"	12' to 20'
Wood Duck	10" square	15" to 18"	4"	8" to 12"	4' to 20'

Purple Martins require homes that have "apartments". The construction of a Martin home is pretty standard; however, for those who might not be acquainted with its construction, here are a few dimensions and drawings on its construction.


29½"
16"
1"
6"
6"
22½"
AIR PASSAGE


16"
29½"
6"
2½"
20½"
20½"


20½"
6"
3/4"
½"
AIR PASSAGE
6"
26½"
2½"

G. BIRD BATHS

One of the major necessities of birds other than feed is water. Birds require water for baths and also for drink. Bird baths made of cement (concrete) or plastic, or even fiberglass can be purchased commercially. The cost of such units, however, can be prohibitive. An alternative to the purchase of such units can be their construction from surplus materials. Although they may lack the beauty of the commercially bought units, these bird baths have the advantage of being cheap to produce and also in many instances birds prefer them as they are more readily adaptable to the environment.

All three baths may be left on the ground or may be elevated on some sort of pedestal. We have found the following to work very well in the capacity of bird baths: 1) Old automobile hub caps; 2) 55 gallon oil drum lids; 3) Bottoms of polyethylene buckets. The pedestals were made from 2" X 4" pieces of lumber which were pointed at one end and driven into the ground. The total length of the pedestal is three feet before insertion into the ground. The bath is then affixed to the pedestal by the use of a galvanized nail. To prevent leakage around the nail it is advisable to coat the area surrounding the nail with an application of silicone rubber.

H. BIRD PHOTOGRAPHY

When one wishes to photograph animals whether they be birds, small mammals, or insects, special needs should be met by the camera. Among these the camera should be equipped with a reflex finder which enables the cameraman to know the exact field and focus of the subject he wishes to photograph. Critical focus of birds which are fast moving cannot be obtained by any other means. A camera should also be equipped with a fast lens; that is, a lens which has a large diameter and a small focal length. Lenses such as this should have an f number of either 1.9 or 2.7 for close-up work; for distance shots the recommended focal length should not exceed 4.5.

Another requirement of a wildlife camera is that it should have a telephoto lens to enable the camera to blow up distant shots. Successful animal photography lenses of this type have a focal length of between 2 and 6 inches. Again, as with other lenses, the telephoto should have a small f number. Other devices which are not mandatory, but are helpful in obtaining clear distance shots, are extension tubes and tripods. Extension tubes enable the cameraman to obtain large images of nearby objects, which cannot be obtained by the use of a telephoto lens. Tripod attachments provide a steady platform from which to shoot distance shots.

One note should be kept in mind when photographing birds from a blind and that is that any photography of wildlife requires patience. Also, when entering a blind, the birds should not be present in the nest. If birds are present in the nest a decoy person should walk by the blind to keep the birds preoccupied while the photographer enters the blind.

I. BIRD'S NEST EXPERIMENT

This experiment must be conducted in the fall when the inhabitants of the nests have long gone. Essentially the object of the experiment is to determine the relation bird population per acre, like relative frequency of species per acre, and the number of species per acre.

To make the task of scouting the area a great deal simpler, the acre is divided into 25 equal parts. Therefore, in a class of 24 students, each student will canvas 1 plot and the teacher will canvas the remaining plot.

After all the nests have been collected they are removed to the classrooms. In the next lab session the nests are examined to determine what species utilized them, and also how many species were present in the acre.

This is an open ended experiment which can be repeated on a yearly basis in the same area. A study of this nature done over a 10-year period would give an indication also of the increase or decrease in population of a particular species and also the relation abundance of birds in the habitat.

As a further study it would be interesting to do a similar study on a field, a hardwood's woodlot, a pine forest, and a bog. The tabulated results could be compared and notations as to the relative abundance of a particular species per habitat noted and also of this were conducted for several years the decline or use of particular species would be known for any particular species would be known for any particular habitat or a combination of all.

J. BIRD BANDING

The trapping or capture of birds for other than scientific reasons, such as the study of migratory routes population frequency and bonding of birds is illegal. In any case, in order to be able to capture a bird for study or for banding, two permits must be obtained. The first permit is applied for to Chief Fish and Wildlife Service, United States Department of the Interior, Washington, D.C. The second permit is obtained from the wildlife control agency in the state you wish to work in. Both permits require an explanation of studies to be done and the recommendation of a recognized ornithologist as to your proficiency in the area of study.

These permits are not granted lightly and therefore banding studies do not apply to everyone.

DATA SHEET

SPECIES		# of nests/ acre of Hardwood Lots	# of nests/ acre of Pine Forest	# of nests/ acre of field	# of nests/ acre of bog
Common Name	Scientific Name				
1.					
2.					
3.					
4.					
5.					
6.					
7.					
8.					
9.					
10.					
11.					
12.					
13.					
14.					
15.					
16.					
17.					
18.					
19.					
20.					

Total # of nests:

Habitat which contains the greatest number of nests for each species:

SPECIES

	SCIENTIFIC NAME	HABITAT
1.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		
11.		
12.		
13.		
14.		
15.		
16.		
17.		
18.		
19.		
20.		

VI. INSECT STUDY UNITS

A. Introduction

Any terrestrial studies guide would be incomplete if the insects were left out. Of all classes under Phylum Arthropoda, Insecta by far outnumbers all others. This great class, in fact, makes up the most numerous group among all living animals in existence today. Despite our so-called modern technology in pesticide control, the insects continue to flourish and in many instances become resistant to our sprays. It is unfortunate to note, however, that oftentimes the insects that die from the sprays are the ones we do not want to die. This includes the pollinators such as the honey bee. Can you imagine a world without honey? The dessert of queens, medicine for the sick, a high-energy food, and all from the little bee. What child has lived to attain adulthood without being enchanted by the vivid colors of the butterflies or being intensely curious as to why a lightning bug lights up?

On the other side of the coin, we are all familiar with the defoliation of trees by the caterpillar of one species and the destruction of forest ecosystems by the sawflies. Human suffering and disease come from a great number of insects that are vectors for some of the world's most dangerous parasites. To mention a couple, the Anopheles mosquito has spread malaria, causing death on a global scale, killing more people than all who have died in all the wars of the world; and another mosquito with a bad track record is the Aedes, spreader of yellow fever. The bites of mosquitoes and flies have plagued and tormented men since Adam was forced to put on the fig leaf. Insects are used as food by man, fried and chocolate coated, or raw and still kicking as by the Australian aborigines who feed on a type of desert ant that moves in vast armies. Animals also eat insects, and for many it is their only food source. Yet we threaten the very existence of these animals with our D.D.T. and other potent and lethal insecticides. From the camphor ant we obtain medicine, from the lac beetle shellac, and from others a vast list of items that make life easy for mankind. Today the entomologist is beginning to win his battle in educating the public to the need to coexist with our so-called pests, and by biological control have certain species become our warriors and executioners, killing off the undesirable insects. Where would the science of genetics be without the lowly fruit fly? The above are just a few items to promote discussion and create interest before the first field trip. These few units presenting some activities that the teacher and students can become involved in are by no stretch of the imagination meant to be final or conclusive. It is our hope they will be a stimulating influence leading to other and perhaps more rewarding experiences. It is our topmost desire, however, that the student become aware of the insects' place in our biosphere and our dependency upon some of them.

B. Unit on Metamorphosis #1

Because many of our insects get their start in or under the water, and because of the various methods of camouflage used by some of these while in the lanval form, or the type of temporary home they build while in or under the water, we will start our study of insects in the field by studying the lanval forms of several selected species. At the same time we can study a few types that spend all or most of their lives in or under water. There is no better place to study metamorphosis than in a shallow brook. Before we head out to the brooklets, collect a few tools and needed items.

What do we need?

1. Weather permitting, a pair of old sneakers or waders.

2. Insect repellent.

3. A stream bottom sampler such as the Surber Square Foot Sampler or a device such as the stream bottom sampler described in "Student-made Environmental Studies Equipment Manual" by St. Anselm's College and the Manchester Public School System.

4. Stiff-bristled brushes.

5. Collection bottles.

6. Birch branches--suitable to act as brooms for sweeping down the brook.

7. A magnifying glass.

8. A prepared sheet listing possible specimens that will serve as a check list.

Procedure: Place four bottom samplers an equal distance apart across a shallow section of the brook. Place rocks in back of them to support the frames, and rocks to the sides to form a dam between all nets, so no specimens escape. This should be done by only a few students so as to not stir up the brook till all nets are in place. Keep others out of the brook until then. Students placing the nets walk to right or left in a straight line to the banks, and then, joined by the other students, progress up the brook against the current (while walking along the banks--not in the water). When they have arrived at the distance decided upon to cover, have them enter the brook and start the operation. Using macroscopic techniques, pluck off any specimens that are easy to dislodge from rocks or sticks, and place them in collection bottles as to species. Now using the stiff-bristled brush, brush all areas of the rocks and the sticks while holding them under water, letting the current carry any small or species held by substrate to your nets. Replace the rocks as closely as possible to where found.

Now moving forward in a line, keep repeating this operation until the students are up to the nets. Leave the brook as before, and return to the point where the students entered the brook. Have them take the birch-brush brooms (or whatever suitable type you have in your area), and start the sweep walking slowly in a line, sweeping and stirring up the bottom. A group of students can follow, replacing any large stones dislodged, and also catching any elusive forms that have escaped and are capable of swimming against the current in their direction, with small dip nets. When the students reach the nets, a survey should be made of the rocks for any forms that missed the nets and attached to the rocks. Before removing the nets, look around for any plants surmerged, or with submerged stems near the banks. Wipe these gently to dislodge the mucoid forms of periphyton and aufwuchs and other larval forms with your fingers, holding your dip nets close in order to catch these forms. Look under the banks and on ledges in the brook for rock cases, holding such forms as the caddis fly, and sticks all cut the same that could be hiding insects. Empty these dip nets along with your bottom samplers into long, shallow white-enameled pans (preferably) with just enough water to cover them, and weather permitting, set up a card table with a bioscope and a regular student microscope and start your study. If weather is not favorable for outdoor examination of your haul, place the specimens in jars or specimen bottles and return to the laboratory to continue your studies. If times runs out, place your specimens in the white trays back at the school with ample water, and they will survive for the next day's laboratory examination. Label and preserve in specimen jars or whatever other preservation method you elect to use.

A good reference on bottom forms is "Freshwater Ecology" by Prentice-Hall, edited by Andrews, 1972 edition. Another valuable reference would be, "A curriculum Activities Guide to Water Pollution and Environmental Studies" produced by the Institute for Environmental Education, Cleaveland Heights, Ohio 44118.

C. Insect Collection--Sweep Collection #2

One of the best methods for the collection of insects, and also one of the best activities that an ecology class can have, is the collection of insects using nets. If the collection of insects using this method is done carefully the results will be very quantitative.

Essentially the method consists of following three parallel transects along a given line. One should note here that the area to be studied should not be disturbed before the procedure actually begins. Therefore, keeping back of the area will ensure the obtainment of good results. If possible, the middle transect should be on shrubs. The sweep is done by moving the insect net through an area of 100 degrees while maintaining a height of about 1 meter. The sweeps of the net should total 50. (NOTE: At the end of each sweep the net should be twisted closed to prevent the loss of any insects.) After the sweep on the middle transect the two side transects are swept at an average height of about .75 meters. The total number of strokes again, on each side, should total 50. When vegetation is of the low form and no shrubs are available the sweeps can all be done just above ground level to a height of about 1 meter.

When each transect has been swept the net should be emptied. In order to accomplish this the net has to be maintained closed while some killing agent is applied to it. Agents such as carbon tetrachloride, ether, ethyl alcohol, or methyl alcohol are all successful. Of the killing agents listed the first two are the most dangerous to use with young students and I recommend the last two.

After the insects in the net have been killed, the net is emptied into a jar and taken back to class for identification and species tally, or the insects can be dropped onto a sheet of clean white cardboard and the tally done in the field.

Using this procedure it is possible when covering the same area on a yearly basis to determine the organisms which are characteristic to the area and these which might be epidemic at the time.

D. Searching for Crypotozoites: (Crypto-hidden) Hidden Animals #3

Almost everyone has sometime in his life turned over an old board in a field or back lot, or a part of a cardboard box, piece of tin, or some other item, that can serve as a place for animals to hide. A typical find would include crickets, roaches, ground beetles, and spiders as being the most numerous. Up to 144 species were observed by one author in an old field survey in a two-year study. To hasten the odds, make ten cryptozoa boards that are one square foot and place a different substrate under each one.

For example, pick a field near your school, the slope of the football field, or some other area with grass cover.

Procedure:

1. Place your first cryptozoa board on the grass itself.
2. Place a leaf mulch or leaves you have shredded and soaked under the second board.
3. Place another leaf mulch of dry unshredded leaves under the third board.
4. Put a mixture of potting soil and leaves under the fourth.
5. Under the fifth board, put a mixture of shredded leaves and bark from pine or spruce trees.
6. Repeat as above, using grass and bark instead of leaves under board six.
7. Place a mixture of shredded paper and sawdust under board seven.
8. Put plain sawdust under board eight.

9. Under board nine put dry straw.

10. Under board ten, put wet straw and a soil mixture.

Each day make a call on your boards and carefully collect and classify your insects and any other animals.

Do you notice any types that are always there? List them. List other types not considered insects.

Substitute cardboard one square foot in place of your wooden boards and observe during the next three checks for any new species. Record as before.

E. Examine a Rotten Log for Insects and Eggs #4

In advance of this field trip, perhaps while on one of another type, locate a rotten log in the forest. It is preferable to find one that almost falls apart with little effort on the part of the students. The items to take along are few but important. They are as follows: a plant vasculum, if available, or a plastic bag may be used as a substitute. This item is to return pieces of wood with egg clusters or larval forms to further study back at the school. They must be kept moist so add a bit of sphagnum moss before you leave to your vasculum or bag. A substitute for sphagnum moss would be a wet sponge brought along from the school laboratory. The second item is a small pry bar usually available on loan from the Industrial Arts Department, or a student may bring it in. Collection bottles and labels make up the third and fourth items. A good key on insects that are decomposers or detritivores and members of the saprotroph group. Some teachers like to make out lists or check-off sheets rather than expose good books to the elements. This can be a library function completed in advance of the trip.

When you arrive at the log, assign four students to each side of the log with pry bars or sharpened spring-leaves from cars. These should be students who are not afraid to pick up the insects. Have them slowly pry off pieces and pass them back to another group who will shred this rotten wood, taking care the insects do not get away. It is better to do this over large white enamel pans or a styrofoam container, in order that dropped pieces can be picked up and viewed for egg clutches, etc. Three or four students should be assigned as viewers to stand in back of the students at the logs, keeping a keen eye open for the insects that try a rapid get-away. (NOTE: Some are very fast).

Several logs and different types of trees make for a very interesting laboratory.

Another important unit may be incorporated at the same time as the insect unit, and that is another great decomposer group--the fungi. Here you follow the same procedure only using a key to the fungi and necessary sheets. The many-colored fungi are beautiful and easy to key, as each has a special function. If you are lucky in the damp woods or near lake shores, you may find Staminitis or other slime molds to return to the laboratory for further study. NOTE: Be especially alert when you remove the bark from rotting logs, as other animals might be there and attempt a quick getaway.

F. Cigar Box Display Unit #5

After you have collected insects using the various methods listed in this terrestrial studies guide, and you have classified them and sorted them as to Genus and species, you are ready for permanent mounts.

One of the better methods for mounting and preserving insects to be used at the high school and junior high school level, is the cigar box mount.

Items needed: cigar boxes, saran wrap (or quivalent), insect pins or small diameter straight pins, small paper flags (to serve as labels) and India ink, if available, otherwise regular ink, and styrofoam ½" thick.

Procedure: Have each student bring in his own cigar box, the bottom of which is lined with at least ½" styrofoam. The insects are classified into orders and usually the small white flag is just large enough to write upon the order-Genus and species. Some include the common name. The flag is affixed to the pin and the pin pushed through the insect's body and into the styrofoam holding the insect in place. If the orders are placed in rows, larger insects at the top and smaller successively as we pin downward, it presents a neat display and affords a good key to students in years to follow. Next, using a razorblade, cut out the center of the cover leaving only a half-inch margin around the top of the box to attach the saran wrap to. Staple the saran wrap, or, using masking tape neatly seal it to the underside of the cover. Close the lid with two small nails. This is now a permanent display box.

Another variation is leaving the cover intact and just stretching the saran wrap over the box top and securing it in place and then closing the cover. (Some feel light changes the color of the insects.)

VII

SMALL MAMMAL STUDY

A. Introduction

The great love and interest people of all ages have for small mammals is exhibited in all walks of life. The house cat, dog, rabbits, hamsters, gerbils, and many others are favorite household pets. Other mammal forms have been introduced to the public during the past decade through the T.V. media.

In this unit it is our intent to describe some methods which can be used in the field to expand our understanding of mammals. It is further hoped that this unit might provide a greater appreciation for some of the vanishing species including mink, weasel, beaver, as well as the more abundant types such as squirrel, chipmunk, fox, groundhog, and porcupine.

1. Equidistant Grid Pattern

Select a one acre site (208 X 208 ft.). Evenly space 25 live traps at a distant of 42 ft. X 42 ft. Bait the traps with a 1:1 mixture of oatmeal and peanut butter.

Traps are set for a period of 5 days and visited on a regular daily basis. At the end of each day the animals are set free and the traps are reset. (NOTE: since most rodents are active at night it would be admissible to check the traps during the mornings.) The results are then tabulated on a data sheet similar to the example.

2. Scat Board Method

Small mammals are peculiar in that they search for flat areas upon which to place their droppings. Knowing this it is possible to provide animals in any one area with this convenience by placing flat boards over an area to be studied. The droppings of most animals are characteristic to that organism. This enables one to therefore be able to identify the species present. This dropping experiment is not intended solely for the mice in the area but seems to work equally well for fox, rabbit, and animals of this size.

Essentially the experiment, if done on one-acre plot, can be set up as in the previous experiment. That is, 25 scat boards are set out over a one-acre plot. The scat boards are separated by a distance of 42 X 42 ft. The boards are visited each day over a 5-day period at approximately the same time of day. The results are then tabulated on a data sheet similar to the example on the next page.

DATA SHEET: SMALL MAMMAL STUDY--SCAT BOARD METHOD

DATE:

LOCATION:
(Plot Studied)

SITE:
(#1 thru 25)

NAME Genus Species	# of DROPPINGS
1.	
2.	
3.	
4.	
5.	
6.	
7.	
8.	

DATA SHEET: SMALL MAMMAL STUDY--EQUIDISTANT GRID PATTERN

DATE:

LOCATION:

NAME: Genus Species	SEX: Male or Female or Immature	Weights	Total #/Species
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			

Total # of Animals ______________

B. ANIMAL TRACK STUDY

This is a good activity for classes from Junior High School through Senior High School. The object here is to locate animal tracks make a permanent record of them, and identify them. Once identified, the tracks give us knowledge as to what organisms frequent the area studied and also enables us to determine their size.

Procedure and Materials

1. Strip of cardboard or still construction paper measuring 2" X 18".

2. 1 lb. of plaster of paris.

3. 1 qt. of water and a suitable container for transportation.

4. 1 spatula (small stick or coffee stirrer).

5. Several mixing cups (plastic or disposable coffee cups).

6. 1 box paper clips.

The method involved for making a permanent plaster cast of a track once it has been found is to first of all clean the area around the track of any debris. Secondly, attach the two ends of the cardboard strip with a paper clip. Be certain here that the circle formed is at least 1" longer all around than the animal track. The next step involved is to insert the cardboard ring around the track to a depth of at least 1". Make certain not to disturb the track in this process. The plaster is mixed according to the directions on the container. (NOTE: if the track is fragile looking in appearance it would be admissable to lessen the consistency of the plaster before pouring.) After mixing, the plaster is poured onto the track carefully and allowed to set for the time required.

Once set the track cast is removed back to the class where it can be cleaned and classified with a track key. The results for an area under study such as an acre can then be tabulated and a reasonable census as to the number and types of organisms found there can be achieved.

VIII

SOILS

A. INTRODUCTION TO SOIL DEVELOPMENT

In this section it is our intent to provide some understanding of how soils develop as well as the parameters controlling this development.

It is quite easy for us to focus in on the material referred to as soil. Usually, we picture a loose, unconsolidated mixture of minerals and organic material. Closer visual examination might improve our understanding of this substance. We may, for example, note that this material varies in composition from location to location. Furthermore, differences in coarseness (texture) can be easily detected. Both composition and texture change with location as well as with depth.

Soils are initially formed from the weathering of bedrock in the location they are found (residual soils) or from material which has been transported to their site by some transporting agent (transported soil). Transporting agents might include water, wind, and ice. Once in place the material begins the complex task of soil development.

Residual soils, those formed in the location of the parent material, undergo a breakdown involving physical, chemical, and biological weathering processes. For transported soils the above-mentioned processes as well as transportation play important roles. The distance the soil is transported, means of transportation, as well as the mode of depositions, must all be considered in the development of soil. Physical weathering changes texture as well as the relative amounts of soil fractions. Chemical and biological, on the other hand, result in bringing about chemical change in the soil. The importance of the composition of parent material is greatest during the initial breakdown of material. After this stage, climate seems to be the major element controlling soil development. Another factor to consider is the time a particular soil has been allowed to develop. The more time allowed then the further along a soil will be in its development. Given two soils with controlling factors, the same with the exception of time, it will be seen that the soil allowed to evolve for a longer period of time will be more complete. With time a given section of soil will exhibit a sort of stratification or layered effect called a soil profile.

The dynamics of developing a soil profile seems to be related primarily to existing climates. Given that temperature and moisture control the growth of vegetation as well as determine the amount of fluids that will descend the soils, climate than is the most important role player in soil development.

In locations of high organic growth the organic material will decay and produce organic acids. Acids carried with the descending soil water aid and enhance the weathering process. In the Northeastern U.S., for example, the cool, temperate climate allows for enough rainfall for abundant forest development. The decaying forest debris becomes acid-rich humus and acids descend, and with time, bring about the development of zones.

The zones referred to are easily recognized where the soil is exposed to any depth. Such differences are easily picked out because of color and textural difference. The color changes indicate difference in composition. The uppermost zone (usually referred to as A_1 zone) has a high vegetable content. In this zone humus and organic acids have aided in breaking down the material with the resulting material having a dark black color. The next zone (A_2) is much lighter in color owing to the absence of organic material and minerals which have leeched out and gravitationally carried to a lower zone. This leeched-out zone is quite light in color--usually gray-brown. It is in this zone that the collective activity of acids and descending soil water have left a weathered zone. The weathered material of the A_2 zone is carried to a third zone (b) sometimes referred to as the zone of accumulation. This zone varies in color from red to brown, depending upon the amounts of iron, humus, and clay present. The lower-most zone (C) is directly above the parent material or bedrock. The lower portion of this zone usually displays coarse, broken fragments of parent material.

Soils formed by weathering, and forming zones as described above, are called podsols, and weathering is referred to as podsolic weathering. A podsol is that gray-brown colored soil formed in the A_2 zone of our described profile.

Examination of a number of profiles (3 zones) usually indicates that very small amounts of organic material actually enter into the B zone. This can be explained by understanding that profile development involves considerable time, and with time organic material will undergo decay. Soil water will carry soluble minerals from higher to lower zones in descending. The transfer of materials follows an order. Clay will descend first, followed by iron. Last to descend will be the humus. The clay will not allow passing of iron particles through it and therefore accounts for presence of both iron and clay in the B zone together. The B zone may accumulate a high clay content and become compacted, forming a material called hardpan. Farmlands ploughed frequently remix settled-out fractions and prevent the development of hardpan.

Podsolic weathering and soil profiles can be observed in areas of new construction. Road and residential development frequently require the existing soils to be disturbed. At such sites the newly developed slopes bein the development of soil profiles. Those profiles present on well-drained areas show the clay content low in the profile development. The less well-drained areas such as swamps or bogs exhibit clay and silts high in the upper zones.

The above described podsolic weathering explains that which is taking place in Northeast, U. S. Other locations, either west or south of this general area bring climatic changes and accompanying differences in the ways the soils weather. Tropical climates are moist and warm resulting in high vegetation and high decay. Weathering in this type of climate is maximum and produces thick, well-developed, red-yellow soil called a laterite. In southeastern U. S., however, the soil is a combination of the podsolic of the northeast and laterite of tropical zones.

In western U. S. we find a marked decrease in moisture content. The subhumid, semiarid, and arid climates have smaller amounts of organic debris and moisture, resulting in indistinct profiles. Also, as we proceed westward we begin to find the appearance of a calcareors layer. This layer, or horizon, is deeper in the moister climates and at the surface where moisture is absent. Also, in drier climates, physical weathering is the predominant process because of scarcity of moisture and vegetation.

B. SOIL PARTICLE SIZE

The size of individual soil particles determines the type of soil being tested. In the next section we will talk about chemical content. Here we will be concerned only with the physical properties. Soil texture is the size of mineral particles and soil structure is the arrangement of the soil particles into groups or aggregates.

A soil separate is a convenient grouping of soils according to sizes. The various groups are spoken of as separates. There are different systems of classification and here we will diagram the United States Department of Agriculture System and the international system. (See Table 1).

In the first column is listed the various range of soil separates. The second is the diameter limits according to the system used by the Department of Agriculture System. The third and fourth column show the percentages of each separate in two very different specimen soils to get such percentages a sample of soil is broken up and the very fine sand and larger fractions are separated into the arbitrary groups by sieving. The silt and clay percentages are then determined by methods which depend upon the rate of settling of these two separates from suspension. In the fifth column, the range in size of the four separates used in the international system is given.

To determine percentage of a certain soil separate is quite simple. When particles are suspended in water they tend to sink proportional to their size. The second step is determination by some successive grades and the third step is the determination of the percentage of each group of particles based on the original sample.

Other methods of soil separating is the use of sieves and sifting devices.

A sieve is a tool built with many different size holes to allow different separates to go through. Under each screen of different size is a container to collect that specific sample.

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*Description of terms on Figure 2: surface soil, zone of maximum organic accumulation, coincides more or less closely with farrow slice. Subsoil, character is determined to a considerable degree by nature of soil forming forces. Substratum, usually more or less weathered.

This is a representative soil profile. The surface horizons are relatively high in organic matter and become the furrow-slice when the land is plowed. The subsoil, while markedly weathered, usually contains but little organic matter at variable depths it merges more or less gradually into the substratum (parent material). All of the layers above the substratum are spoken of collectively as the solun.

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Soil Separate	Diameter Limits	Analysis of two typical soils		International System
		Sandy Loam % -	Clay Loam %	
very coarse sand	2.00 - 1.00	3.1	2.2	
coarse sand	1.00 - 0.50	10.5	4.0	2.00 - 2.0
medium sand	0.50 - 0.25	8.2	6.3	
fine sand	0.25 - 0.10	25.3	8.4	0.20 - 0.02
very fine sand	0.10 - 0.05	22.0	9.6	
silt	0.05 - 0.002	21.1	37.2	0.02 - 0.002
clay	below 0.002	9.8	32.3	below 0.002

Table 1

from Soil Survey Manual (U.S. Dept. of Agriculture Handbook, No 18, 1951). p. 207

Soil Analyses Report Form

name

class

date

Sample number	#1	#2	#3	#4
Source of Sample				
Characteristics: Color→				
odor→				
Analyses: PH				
Nitrogen				
Phosphorus				
Potassium				
Classification:				
Observations:				

Table 2

A sieve is a tool used to take one specific soil separate out of a sample. It has one screen and allows only up to that size sample to get through.

Once a percentage of soil separates is determined a diagram may be used which will determine the name of the soil being tested. (See Figure 3).

C. SOIL TESTING AND SOIL TESTING KITS

For the chemical content of the soil we used the LaMotte soil testing kits. We are, however, not publicizing this kit but it did serve our basic purpose of testing for pH, nitrogen, phosphorus, and potassium.

Included in the kit is a soil analyses report form which we will refer to in this section. There are also detailed instructions included on the form. We will reproduce the report form. (Table 2).

When obtaining a soil sample a very crude but satisfactory method is to use a 98¢ bulb planter found in any hardware store.

The reader should refer to figure 4 while we show some basic steps in evaluating the soil.

First, tell where the sample came from: home garden, meadow, forest, etc. Second, notice the color as this is a clue to its origin and possibly to the process by which it was formed. Third, if you notice a predominant smell it is probably from decomposed vegetable matter, insecticides, fungicides, and chemical fertilizers, chemical wastes etc. Fourth, a pH test should be run to determine the acidity of the soil. Fifth, a nitrogen test. Sixth, a phosphorus test. Seventh, a potassium test.

Now, for the classification, the tester may go to the extent of using a sieve as we explained or he may use a rough guesstimate method. Rub moist soil between the fingers. If it feels gritty, it is predominantly silt; if it feels sticky, it is predominantly clay.

Finally for observations, you should review the data obtained in your investigation of the soil samples. Were the samples similar in their characteristics or did they vary? What was growing in the soil? Was it growing well or was it struggling? Was the soil compacted or loosely packed?

If you were responsible for growing plants on these soils, would you want to change them in any way?

Taking a step back now we will describe in more detail the method used to test for pH, nitrogen, phosphorus, and potassium.

pH Test

1. Add Tricon flocculating solution to the line on the soil pH test tube.

2. Using the plastic measuring spoon (p. 5g), add three level measures of the soil sample to the test tube.

3. Stopper the pH test tube and gently shake by inverting the tube back and forth slowly for one minute. Allow the soil particles to settle in the tube.

NOTE: The amount of time required for a soil to settle varies with texture; clay soils may require additional time, but in most instances the soil solution will be clear in several minutes.

4. Add 6 drops of tricon soil pH indicator.

5. Invert the test tube gently one time to mix the contents. Allow the soil to settle and a clear color to develop in the test tube before making the reading in the comparator.

6. Place the test tube in the tucon pH comparator and compare the color in the test tube with the colors in the comparator. The color in the comparator which most nearly matches the color in the test tube is taken as the pH value of the soil sample. A color that appears to be halfway between the colors shown by the comparator may be interpreted as half values.

EXAMPLE: A color that is halfway between pH 4.0 and pH 5.0 may be estimated to be pH 4.5. (Instructions--LaMotte soil pH test).

Nitrate/Nitrogen Soil Test

1. Fill a 1-8 ml test tube to line 7 with Universal extracting solution.

2. Using the plastic measuring cup (2.5g), add one level measure of soil to the test tube.

3. Stopper the test tube and shake for one minute.

4. The soil suspension is then filtered into a clean filtrate tube. The filtration is carried out in the following manner: a circular piece of filter paper is first folded through the middle to make a half circle and then folded again to make a quarter circle. This is then opened at one circular end to form a cone which is filtered into the funnel.

5. Using the 1cc dropper pipette, transfer 1cc of soil filtrate to one of the depressions on the spot plate.

6. Add 10 drops of nitrate reagent 1.

7. Using the plastic measuring spoon (0.5g) add one spoonful of nitrate reagent 2, stir thoroughly with plastic rod.

8. After five minutes, the resulting pink color is compared with the nitrate-nitrogen color chart. (Instructions--LaMotte Nitrate-Nitrogen Soil Test).

Phosphorus Soil Test

1. Fill a 1-8 ml test tube to line 7 with Universal extracting solution.

2. Using the plastic measuring cup (2.5g), add one level measure of soil to the test tube.

3. Stopper the test tube and shake for one minute.

4. The soil suspension is filtered into a clean filtrate tube. The filtration is carried out in the manner described in the nitrogen test.

5. The phosphorus "B" tube is filled to the mark with the filtered soil extract from the filtrate tube.

6. Add 6 drops of phosphorus reagent 2 and swirl the tube to mix the contents.

7. Add 1 tablet of phosphorus reagent 3 and shake the tube until the tablet is dissolved.

8. Compare immediately with the phosphorus color chart.

PRECAUTIONS: This test is so extremely sensitive that it is necessary to take special precautions to keep out all contamination. The hands of the operator, the desk or table on which he is working, and everything that comes in contact with the hands, or materials, should be scrupulously clean. Never allow any part of the apparatus to be exposed to fertilizer dust. (Instructions--LaMotte Phosphorus Soil Test).

Potassium Soil Test

1. Fill a 1-8 ml test tube to line 7 with Universal extracting solution.

2. Using the plastic measuring cup (2.5g), add one level measure of soil to the test tube.

3. Stopper the test tube and shake for one minute.

4. The soil suspension is then filtered into a clean filtrate tube. The filtration procedure is the same as described in all the previous tests.

5. Fill a clean 1-8 ml test tube to line 3 with a portion of the filtered soil extracted from the filtrate tube.

6. Add 1 potassium reagent B tablet to the test sample in the test tube. Cap the test tube and shake to dissolve the tablet.

7. Add potassium reagent C until the level of the solution is raised to line 7. Allow it to run slowly down the side of the tube. Mix by gently swirling the tube. A precipitate indicates the presence of potassium; the amount depending upon the quantity of precipitate formed.

8. Place a potassium "B" tube in the clip in the reading stand. The stand should be facing a window or some other source of daylight. The tube should be one-half inch above the plate.

9. By means of the dropping pipette, add the test sample slowly, allowing it to run down the sides of the tube while observing the black line through the solution. This is continued until the line just disappears.

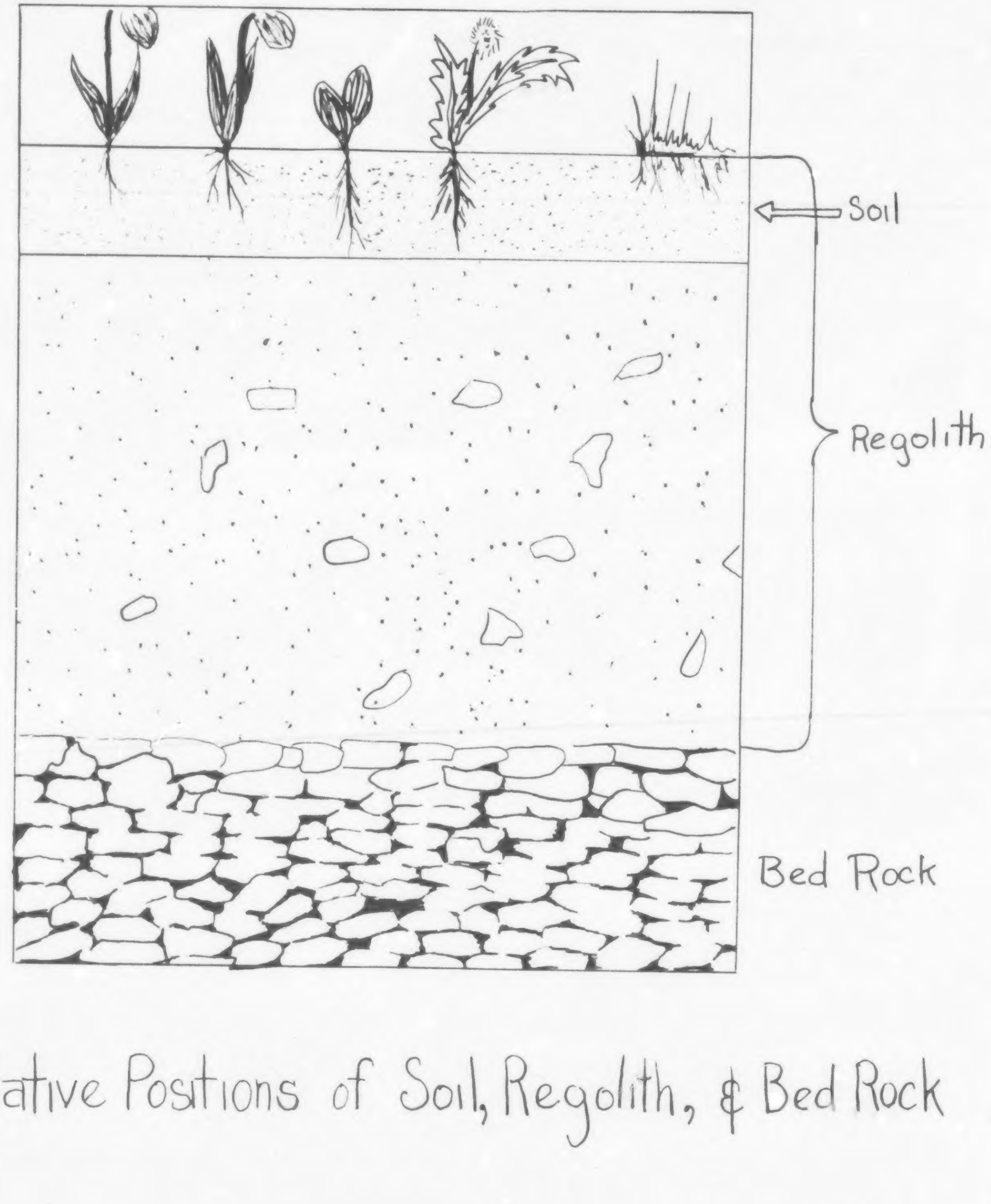
10. The height of the column of test sample is measured against the potassium scale on the tube. The potassium content of the soil in pounds per acre is read directly from the tube. (Instructions--LaMotte potassium soil test).

Hopefully, by reading this section the student will realize how simple it is to do basic soil tests. Any student of ecology or home gardeners can take this test kit and determine any chemical deficiencies and adjust accordingly to the needs of the plants to be grown.

With the help of Figure 3, and some simple sieves, a fairly accurate test of the physical properties of the soil may be determined.

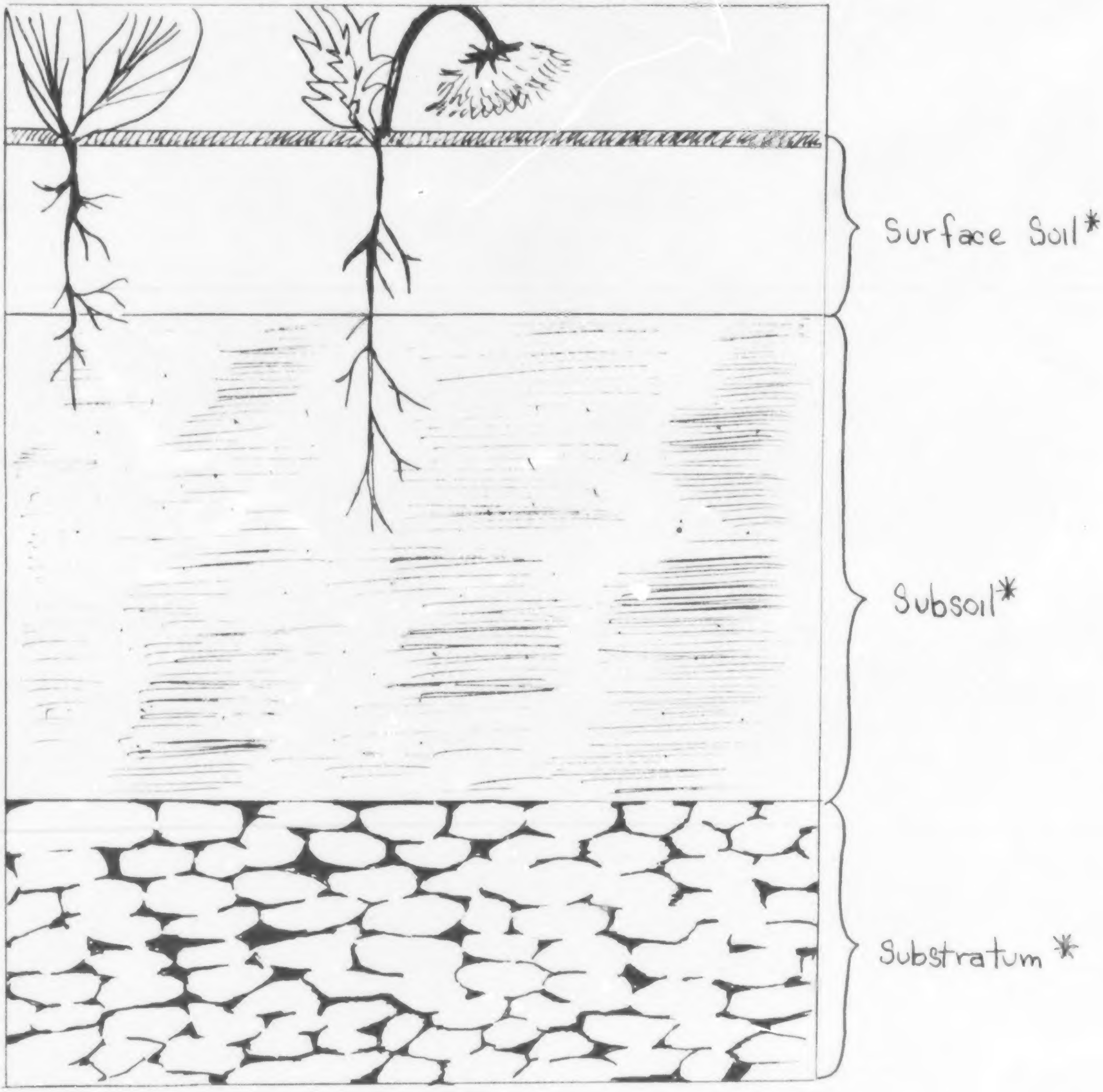
It is hoped that the student and any environmentally conscious person will keep the needs of our soil in mind and will always realize that the soil is basic to our life on earth.

Figure 1


Soil
Regolith
Bed Rock

Relative Positions of Soil, Regolith, & Bed Rock

Figure 2


Surface Soil*
Subsoil*
Substratum *

*for description, see text

D. Activities

1. In your locality find suitable locations for visual examination of soil profiles. Areas of new construction usually require cutting through well-developed profiles. If possible compare profiles of well-drained areas with those of less well-drained areas.

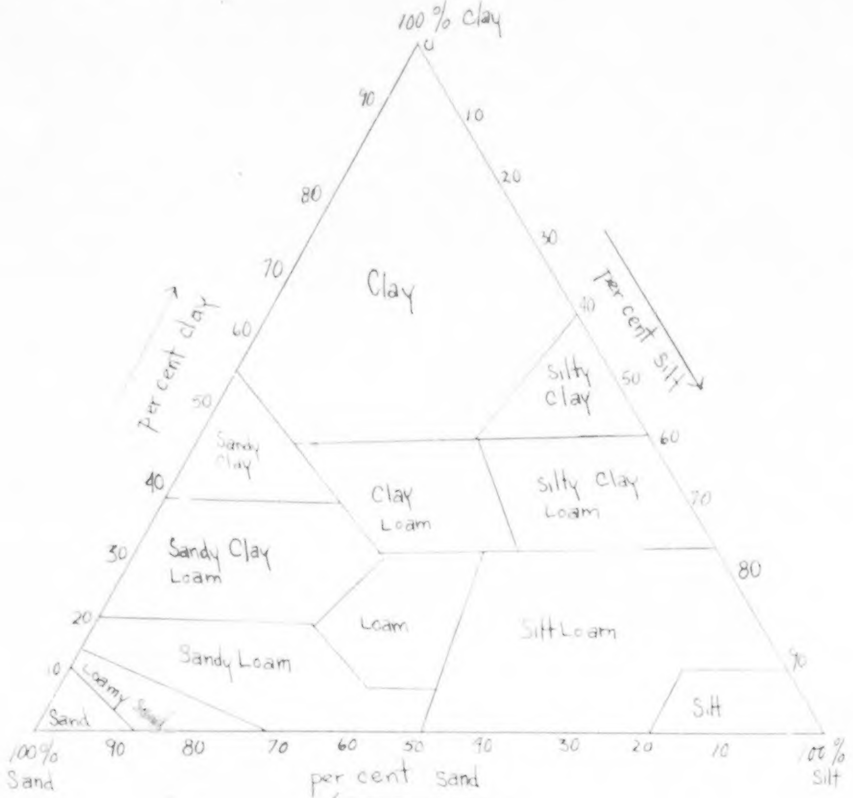
2. Find locations where soils have been developing profiles for different lengths of time.

3. Take photographic prints, slides, or construct diagrams of different profiles. Bring into classroom for discussion.

4. Using soil test kits determine the percentages of sand, silt, clay, and organic debris in A_1, A_2, B and C horizons.

5. Using soil testing kits determine pH change with depth in the profile. Discuss reasons for this change.

6. Using soil testing kits, test soil samples for pH, nitrate-nitrogen, phospherous (Poy) and Potassium.


100 % clay
0
90
10
80
20
70
30
60
40
50
50
40
60
30
70
20
80
10
90
Per cent clay
Per cent Silt
Clay
Silty clay
Sandy Clay
Clay Loam
Silty Clay Loam
Sandy Clay Loam
Loam
Silt Loam
Sandy Loam
Loamy Sand
Sand
Silt
100% Sand
90
80
70
60
50
40
30
20
10
100 % Silt
per cent Sand

IX

PLANT ECOLOGY

A. Introduction

It is with great concern and alarm that man has finally cried out against the rape of the autotrophic world, the producers, the plants of the world. The Cedars of Lebanon have been gone for centuries, and the Black Forest of Austria has shrunk to a mere woodlot when compared to its former grandeur, while the great Red Wood forests of California are shrinking daily through the carelessness of mankind. We are now feeling the bitter effects of the concrete jungle syndrone here in America, as supermarkets, shopping centers, and industrial complexes bulldoze away vast acreage of the greebelt. Not even a weed is left as the asphalt and concrete are poured and the photochemical smog becomes thicker above. To be sure, some concerns plant a few azaleas or rhododendrons in front of the store along with some yew or cedar shrubs to brighten things up a bit. We can be certain, however, few if any were thinking of the importance of plants in keeping CO_2 and CO, along with SO_2 and other gases, in check, helping to maintain a balance. It is only the autotrophic world that can manufacture its own food, man the heterotrophe can't, and is therefore nutritionally dependent upon the plant, while the plant is independent.

With the rapidly growing concern for plants and conservation, especially by the younger generation, new interest has arisen in America and around the biosphere, as well as a revival of some of the old interest. Included among these are all aspects of gardening, and plant studies ranging from keying to pressing and mounting of plants.

Listed in this unit are several of these functions with complete directions on how to become involved.

B. Keying and Identifying Plants

The keying of plants can be a challenging and stimulating exercise, and one that builds and grows on one as he or she progresses. It is like crosswoord puzzles or other forms of leisure addiction such as bridge or cryptograms. It is a progression forward in identifying plants by adding bit by bit to your knowledge through the use of a botanical key. It is important, however, that the right key be chosen at the onset with the student new to botany. A series of failures will surely create a taste that is not botanical. Try to make the first experience a rewarding one--let the students be winners--make it as easy as possible without being impractical.

A good start is to use a key that is illustrative, pictorial, and diagramed, with a minimum of reading involved. There are many such keys on the market, one being "The Tree Identification Book" by George Symonds, with photographs by Stephen V. Chelminski. This book is arranged as follows:

Key #1: Opposite Growth Characteristics

Key #2: Thorns

Key #3: Leaves

Key #4: Flowers

Key #5: Fruit

Key #6: Twigs and buds

Key #7: Bark

There are photographs, and most are of actual size and numbered, i.e., all maples are 96, etc. Once your students have experienced a certain degree of success with this type of book, proceed to one such as the three volumes by Gleason, "The New Britton & Brown Illustrated Flora of the Northeastern United States and Adjacent Canada." This has selected drawings and diagrams, with much more written descriptive literature than that presented by the first type mentioned. After a successful exercise with this type of key, it is time to move into the big time and introduce your students to "Gray's Manual of Botany." If they can master this they are on their way to becoming a budding botanist. It is most important that the teacher assist the beginner by pointing out what to look for, especially as one leaves identification of Genus only and starts for the first time upon speciation. Structural similarities are the main things one looks for here, and in some cases it is a fine line that separates one from another. Praise is important at this point; let them know they have done a job when they have correctly identified a plant, even if it is one of the most common and perhaps a simple one. Show them the pitfalls and what to avoid until they are doing well on their own. One final comment--be sure they read the forewords or introductions by the authors in all keys before starting the project.

Vasculum

In the art of pressing plants, it is most important that in those instances where one is returning to the herbarium or laboratory with the plants from the field, that they be kept in as fresh a condition as possible. The most efficient and least cumbersome method in use for the past 50 years has been the use of a vasculum.

The vasculum has traditionally been either a square metal box about $1\frac{1}{2}$' long, 5 to 6" wide, and 5 to 6" deep. Usually it is metal such as heavy gauge galvanized sheet metal, or in recent years some form of vinyl or plastic. Some are rolled to form a tube somewhat like a stovepipe, only slightly oval with a more-or-less flattened bottom. All, however, feature a lift-up cover on top, with a simple hasp of some type as a lock, along with a strap and buckle that is adjustable to one's shoulder. They are leakproof unless turned upside down. In order to keep the plants moist, one may place a wet sponge in the vasculum before leaving the laboratory; or if one is going to an area where there is sphagnum (peat moss), this can be put into the vasculum (be sure it is wet) and it will keep the plants in good condition until your return or for a day or two. Two or three fistfuls should be enough.

Our vasculums, as indicated in the diagram, are of wood frames (shellacked with marine spar varnish) over which we have placed a cover of sturdy plastic sheeting or vinyl materials. It is lighter than most vasculums, thus, easier to carry. Prune your woody plants well and you will be able to carry more and have less work back at the laboratory. Follow your laboratory exercise accompanying the plant press projects for further directions and guidance.

Laboratory Plant Press

The laboratory plant press is different than the field press, in that it is larger and heavier. Another difference is the absence of straps. In the place of straps it has two large threaded rods passing through the base of the press on either side, and the top or press cover has two holes on each side to line up with these two rods.

Once the top is in place and lowered to the topmost cardboard ventilator, thumb screws of a large variety (such as found on spare tires) are screwed down as tightly as you can get them. Periodically (every three or four hours) tighten them again for perfect pressing.

This press is designed for the heavy type plants (trees, roots, fibrous plants) that need greater pressure. It is also handy when you have too many for a regular press and you wish to keep the collection together all in one press. In those schools where there is a shortage of presses for the field, the field presses may be emptied into one of these types, as they hold two regular presses of plants.

NOTE: You still must observe all standard techniques, such as pruning correctly, avoiding knots and the proper positioning of the plants for a perfect press. This information is to be found in all good herbarium books and also often included in botany and classification manuals. Our diagrams for the construction of this piece of equipment are included.

Field Plant Press

The field plant press is the most common and most widely used press by the botanist because of its lightness and its construction. (Diagram for construction included). It is comprised of five basic components as follows: a top and a base (lattice like structures), usually of hardwood slats and pop rivets (sometimes pine is used and staples); a series of perforated or ventilated (honeycombed) cardboard ventilators (see diagram); a series of blotters (may be purchased from botanical supply houses or simply cut from old desk blotters to size indicated in press diagram); one section of newspaper folded to receive the plants; and a set of straps similar to those used by mailmen (buckles with thumb release).

An Experiment (or Project) Using the Vasculum and the Field Press

Plan your trip in advance. Go to the area you have selected and spot the specimens you wish to study. Mark them with a ribbon, tape, or paint if permitted. Draw a sketch of the area and number your stations for easy retracing of the route. Make sure your identifications are correct. If in doubt, use your keys available.

NOTE: This may be done by advanced students who you know are trustworthy.

Alert your class of the upcoming trip and considering the terrain and weather conditions inform them of what type of clothing would be best to wear.

Get out the presses, vasculum, pruners, and necessary identification keys. It is good to run a practice laboratory making sure all students understand what each item is used for. or its place in the press as to position. A few plants carefully selected the afternoon before the practice laboratory and placed in a vasculum along with some sphagnum moss or a sponge (wet) or both will suffice for this lab and pay off in the field in time saved and errors avoided. Be sure to include a plant with a good thick root, a smooth section of stem or trunk, and some twigs. Have some sections with knots on them. Get leaves, buds, bark, fruit or nuts, samara or any part that can be used for identification. (Leave some leaves out overnight.)

Show the student the vasculum and let them note the sphagnum and sponge and the fact the plants are still moist and healthy, despite being picked overnight. Show them some leaves you left out overnight--wilted and poor for pressing. Show them how it is carried by its strap over the shoulder. Select a stem and split it with your pruners or pocket knife (emphasizing proper technique to avoid cutting oneself). Smooth cut side so it will lie flat and even in the press. If there is a small knot, cut it off (explain why to the students) making each section about five to eight inches long, depending on structures you wish to save. Take the other half of this section and split it once more so the bark and some of the wood is gone, leaving a flat section with the heartwood exposed. (Explain that some trees are easily recognized by the heartwood, i.e., nut trees all have a coiled spring-like center, etc.) Prepare the root by splitting it in half to show the center wood. Take a thin slice from this area and also a section from the outer portion of the root. Now snip off the long tapering end of the root with the root hairs attached and wash gently to keep root hairs in tact. Select the leaf, buds, nuts, seeds or whatever else you plan to include in identification of your chosen specimen and prepare them for the press.

Lay the bottom of your press (with raised horizontal bars) down in a well cleared area. Place a ventilated cardboard on top of this (lined up with the sides) and place a dry blotting paper on top. Take one complete sheet from a newspaper and fold it as it is folded on the newsstand (line it up with the blotter) and open it to receive the plants. Start at the top and place your stems, root sections, then your twigs. Lay them flat and even (like one does when mounting the plants). Be sure you don't crowd the plant sections. It is better to go to another setup or section with the flowers and leaves as they are delicate and often a slipping piece of wood or root can tear or split leaves and flowers. Prepare pods and seed holders so seeds are not lost. After they are spread out in their proper places, close the newspaper and lay a top blotter over it. On each sheet write the name of the plant, both genus and species if you know them, plus the common name. Next, put the area you collected in and conditions, i.e., ditch--wet--moist--dry bank--cinder bed--railroad tracks--etc. Put down the name of the town and if from a swamp or brook with a name, list it. The date is now written across the sheet and it is closed. Follow this with the top vented cardboard and follow this sequence until you have filled the press with ten to fifteen plants, depending on size and amounts for each spread. Place the top or press cover in place and line up the straps equal distance from the ends of the press. Start them from under the press about four inches or so from the ends, bring them to the top and buckle them. With an even steady pull, apply pressure, first on one side then on the other, until the straps are as tight as you can get them. (Standing on the press helps). Rapid drying under moderate yet sufficient pressure, is the secret of success in plant preservation.

Place the press above a radiator with moderate heat, or if in a hot room, on a shelf, and adjust your pressure from about 25 pounds gradually to 50 pounds or even up to 100 pounds, if needed, with woody plants. The dryer sheets and blotting papers should be changed twice daily, whenever possible, or whenever they are damp to the touch. These should not be reused until they are well dried. The protective newspapers should not be changed until plants are thoroughly pressed. The time required varies with the season and the succulence of the plant. Four to five days is usually sufficient.

Explain all this to your students with as much visual and hands-on experience as possible. You are now ready to go into the field with your students and have each collect under supervision, stressing good conservation practices and techniques. Have some presses filled in the field following the guidelines set forth in this exercise. Return some plants to the laboratory for corrective measures and for a unit on the laboratory plant press.

Once the students have collected and pressed their specimens and have them dried, they are now ready for mounting them as permanent mounts. Many botanical books give methods to follow and materials to use. We feel individual preferences may be allowed also, or else we stifle expression of true art.

HAVE A GOOD TRIP!

NOTE: While in the field, be sure you have permission to collect in the chosen area. All land belongs to someone. Do not allow limbs, branches, etc. to be broken off. Pruners and trimming only will be tolerated, unless the tree is down. Do nor mark or needlessly cut a tree or ever allow a tree to be girdled. Stay on the paths with your students except when you go to a tree or plant off the path. Then, form a single line to avoid trampling the area. Return single file. Students will not do these things unless you make it a rule with "teeth" in it. Respect for good conservation practices is learned--not always from parents. It is your job to teach it.

1.

THE VASCULUM

If one is to press plants effectively and neatly it cannot be stressed enough that specimens must be in as excellent a condition as possible. This has been made possible in the last 50 years by the use of a vasculum.

The vasculum has traditionally been a rectangular metal box, 1 1/2' in length and 5" wide X 6" high. The materials from which the vasculum has been made have changed in the last few years from galvanized sheet metal to plastic sheathing. All, however, have been essentially waterproof.

In order to keep the plants fresh until returning from the field, a wet sponge or damp peat can be placed in the bottom of the container. This will assure the good condition of the plants for a day or two, provided they are kept away from excessive heat.

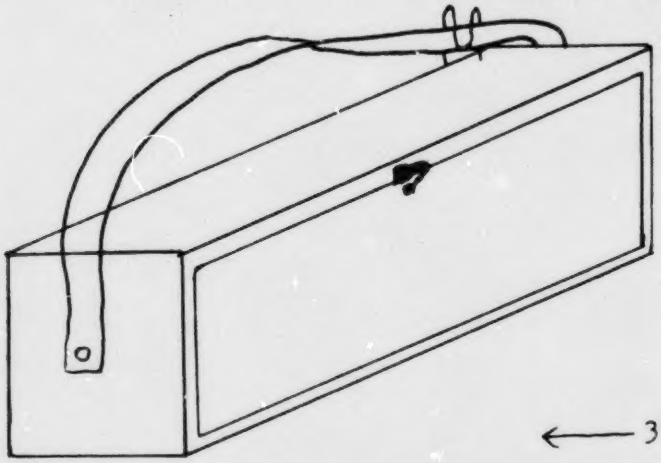
The vasculums which we have designed are of wood frame, which have been shellacked with marine spar varnish. To this frame we have attached a cover of plastic sheathing. This assures a light and very durable vasculum.

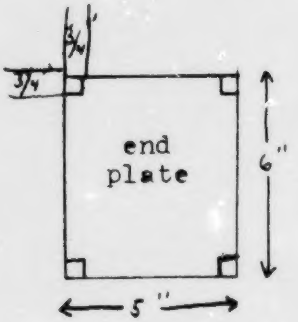
Woody plants placed in the vasculum should be pruned well, thereby assuring ample space for other plants and also providing less work back in the laboratory.

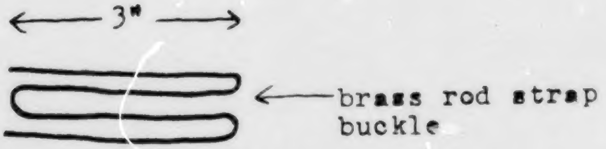
Follow the laboratory exercise accompanying the plant press project for further directions.

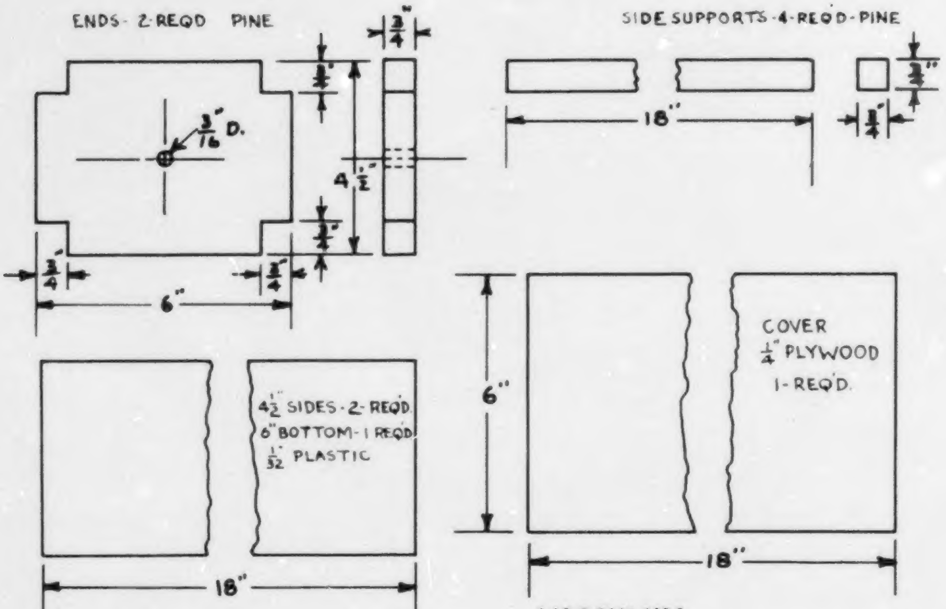
We have found that a vasculum measuring 5" X 6" X 18" to be of functional size.

Materials may vary depending upon availability; however, a wood frame covered with plastic has proved to be an excellent choice. 3/4" pine strapping has been used for the frame.

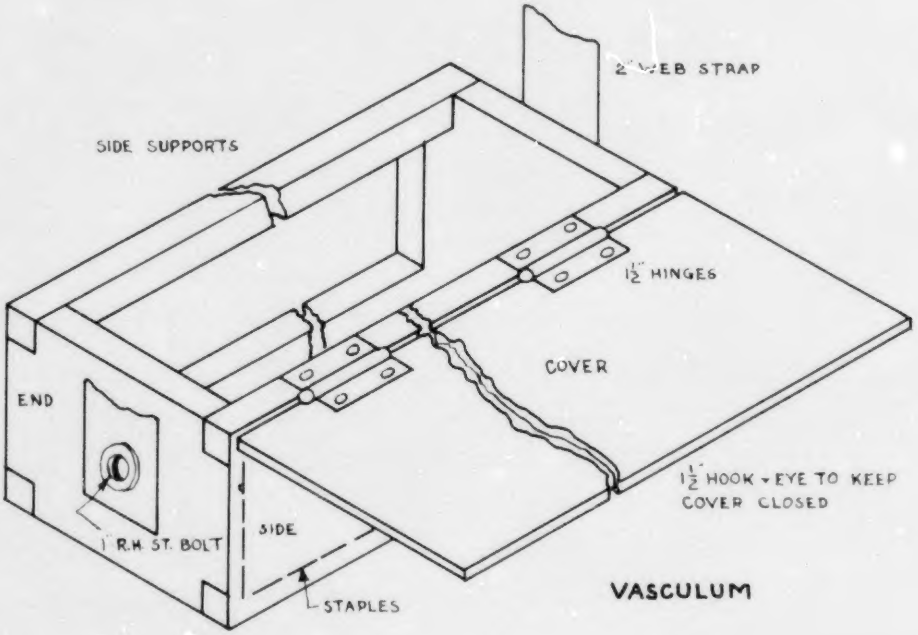







ENDS - 2 - REQD PINE
3/4"
1/2"
3/16" D.
4 1/2"
1/2"
3/4
3/4
6"
SIDE SUPPORTS - 4 - REQD - PINE
18"
3/4"
3/4"
4 1/2" SIDES - 2 - REQD.
6" BOTTOM - 1 REQD.
1/32" PLASTIC
18"
6"
COVER
1/4" PLYWOOD
1 - REQ'D.
18"

VASCULUM


2" WEB STRAP
SIDE SUPPORTS
1 1/2" HINGES
END
COVER
1 1/2" HOOK + EYE TO KEEP COVER CLOSED
1" R.H. ST. BOLT
SIDE
STAPLES

VASCULUM

EXPERIMENT

USE OF VASCULUM AND FIELD PRESS

1. Plan trip in advance by carefully selecting an area to be studied. Identify plants in area which you have selected for student study. Mark them with ribbons or tags.

2. Alert class of upcoming field trip and notify them as to what type of clothing and equipment should be brought.

3. Get presses, pruners, and vasculum out a day ahead of trip. Have a practice lab in which the students are able to work with the materials. Make sure they understand how to use the vasculum, presses, and identification keys.

4. Show students a vasculum in which has been placed plant specimens from the previous day. Also, show students plants which have been left out overnight on a laboratory table. Have them note the wilting, drying out, and deterioration of the plants.

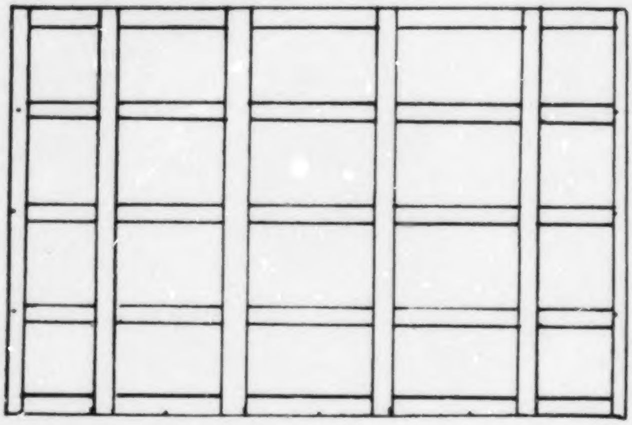
5. Select a stem and split it with a pocket knife, emphasizing to students the proper technique to avoid injury to self. Smooth cut side for proper placement in press. Remove any knots and explain why to the students. Make each section of stem approximately 5" long. Take the other half of this section and split it once more so that the bark and some of the wood is gone leaving a flat section with the heartwood exposed. (Explain that some trees are easily recognized by the heartwood, i.e., nut trees all have a coiled spring-like center). Prepare the root by splitting it in half to show the center wood. Take a thin slice from this area and also a section from the outer portion of the root. Snip off the long tapering portion of the root with the root hairs attached, and wash gently to keep root hairs intact. Select the leaf, buds, nuts, seeds, or whatever else you plan to include in identification of your chosen specimen, and prepare them for the plant press.

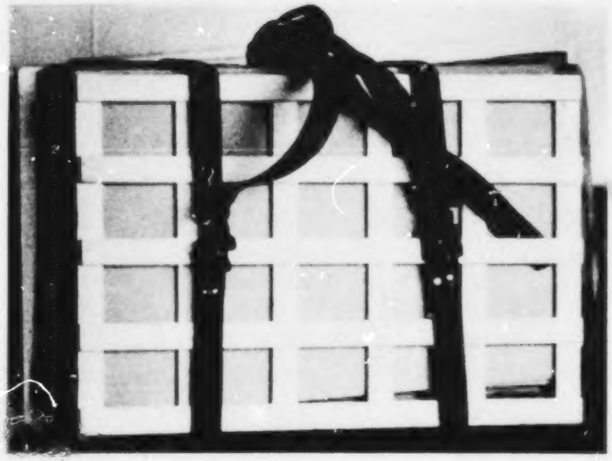
6. Lay the bottom of the press down in a well-cleared area. On this, place a ventilated cardboard and then one complete sheet of newspaper folded in half. Open folded paper to receive plants. Lay section flat and even--be sure not to crowd sections. After they are spread out in their proper places, close newspaper and place a piece of blotting paper over it,

followed with another portion of ventilated cardboard. Place the top of the press in position and line up the straps equidistant from the ends of the press. With a steady, even pressure, tighten straps until they are as tight as can be obtained. Rapid drying under moderate pressure is the secret to plant preservation. Finally, on blank sheets of paper, write the name of the plant, both Genus and species names, plus the common name. Next, put the area collected in and habitat down on paper. The date should also be written on the sheet.

7. Place the press over a radiator with moderate heat. The dryer sheets should be checked daily, and damp sheets of blotting paper removed. The protective newspapers should not be changed until the plants are thoroughly dried. The time required varies with the season and the succulence of the plants. However, four or five days is usually sufficient.

FIELD PLANT PRESS





The field plant press is the most common and most widely used press by botanists, because of its lightness and construction. It is comprised of five basic components: (1) a top and a base (latticelike) usually made of hardwood slats and riveted; (2) a series of ventilated cardboard; (3) a series of blotters; (4) a number of newspaper pages; and (5) a pair of straps similar to the ones used by mailmen, but of at least 60" in length.

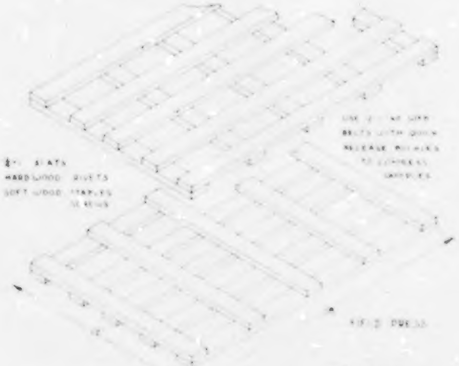
Construction

Cut wood into strips 1/4" thick X 1" wide.

Cut 12 pieces to 12" length.

Cut 10 pieces to 18" length.

Assemble as shown above, using pop rivets or small brass wood screws where slats meet. NOTE: Two panels will have to be made for one press.


¼" SLATS
HARDWOOD RIVETS
SOFT WOOD STAPLES
SCREWS
USE 2-1" WEB
BELTS WITH QUICK
RELEASE BUCKLES
TO COMPRESS
SAMPLES
12"
FIELD PRESS

2. LABORATORY PLANT PRESS

The laboratory plant press is different from the field press, in that it is larger and heavier. Another difference is the absence of straps. In the place of straps, it has two large threaded rods passing through the base on either side and in a similar manner through the top. Large thumb screws (spare tire type) are fastened to the threaded rods and the pressure is tightened once it is full. Periodically, every three or four hours, the press is tightened for perfect pressure. This press is large enough to accommodate two field presses.

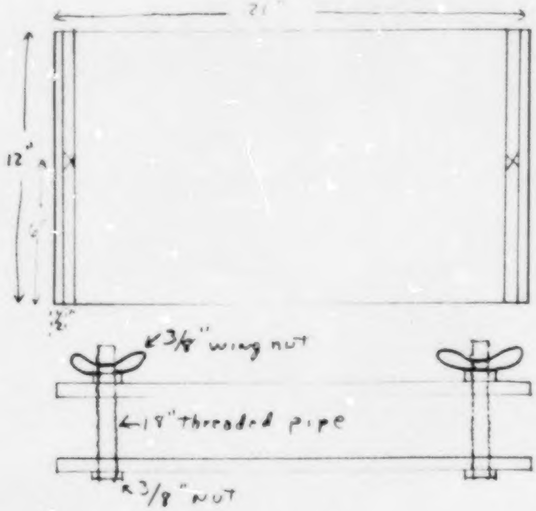
Materials

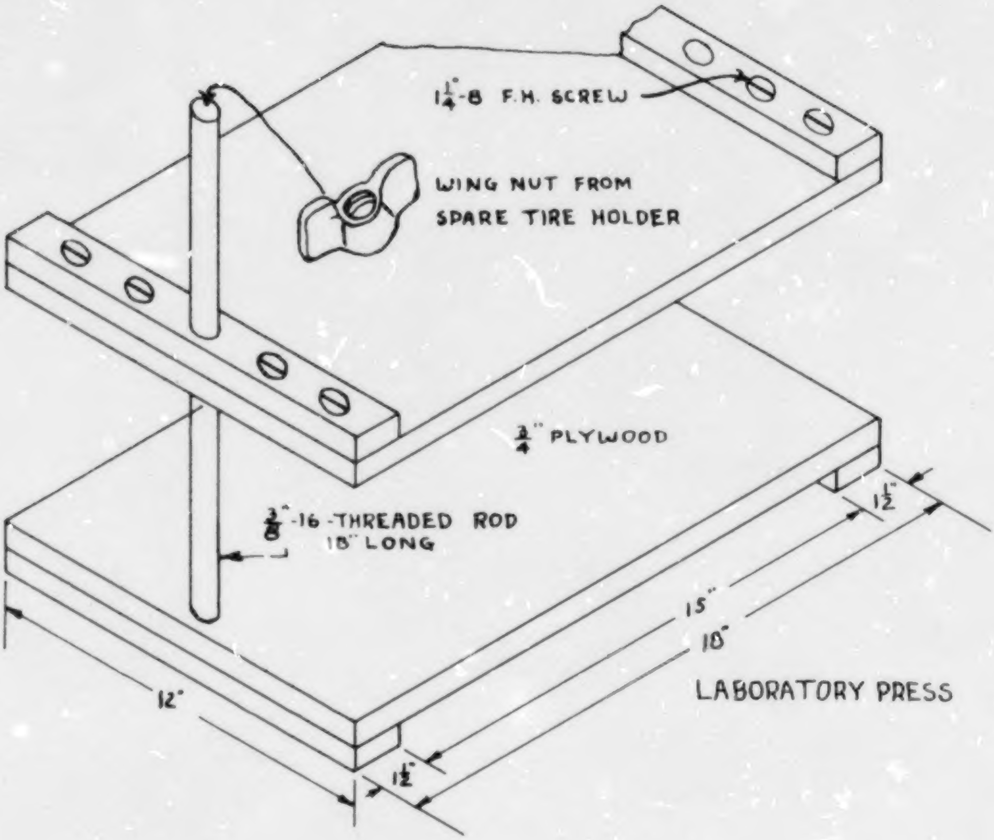
2 pieces of 1/2" or 3/4" plywood (exterior grade), size 12" X 21".

2 pieces of plywood 3/4" X 1" X 12".

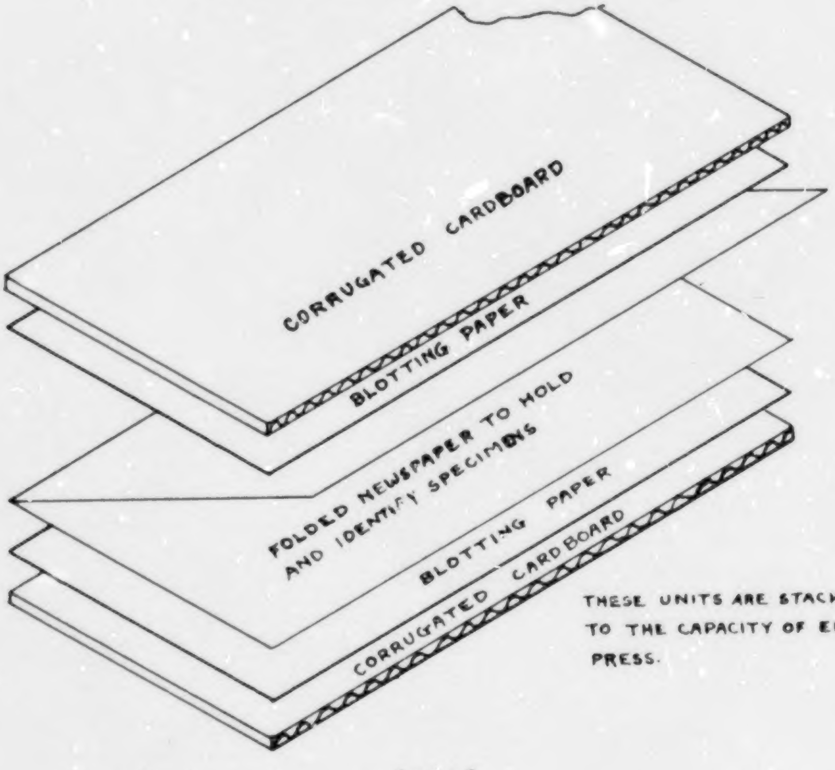
Construction

Screw the 1" strips to each 12" X 21" piece as shown. Drill a 3/8" hole at points marked by an "x". Take two 18" pieces of 3/8" threaded pipe and place a 3/8" nut on one end of each. Set the nut into the 1" slat so that the press will sit flat. Place the other half of press over the top of the pipes and screw on two 3/8" wingnuts. Varnish all sides.




1¼"-8 F.H. SCREW
WING NUT FROM SPARE TIRE HOLDER
¾" PLYWOOD
⅜"-16-THREADED ROD 18" LONG
1½"
15"
10"
12"
1½"

LABORATORY PRESS


CORRUGATED CARDBOARD
BLOTTING PAPER
FOLDED NEWSPAPER TO HOLD AND IDENTIFY SPECIMENS
BLOTTING PAPER
CORRUGATED CARDBOARD

THESE UNITS ARE STACKED TO THE CAPACITY OF EITHER PRESS.

3. MOUNTING PLANTS THAT HAVE BEEN PRESSED

No rules can be applied that are to be considered (so-called) "hard and fast" rules. Individual preferences, artistic expression, creativity, as well as allowable space under set conditions and time factors, will all play a part. Most modern botanists like to let the student have his own way to a certain extent, dependent upon the different objects which the collectors have in view. If the student is planning to handle the specimens often, such as to place them under a micro or dissection scope, obviously one would not glue them to the herbarium mounting paper. In the above instance adhesive paper strips would be a recommended method. The following are methods used by the author of this article. Some were taught to him by various botanists, while others are his own modifications of methods he learned so long ago he cannot recall the source. In all instances, however, while involved in a formal course of study, you would be well advised to do it exactly as the professor or instructor directs you to do--at least if you desire a decent grade.

The so-called standard herbarium mounting paper is a good quality white calendered paper. If not precut it should be cut to the uniform size of 11½" X 16½". This is standard size for herbarium permanent mounts. Assuming the collector has collected, pruned and pressed enough variety and samples, select the specimens that will make the best mount or spread. Place them upon the mounting paper, trying different arrangements before gluing, taping, sewing, or paper slit locking, whatever your planned method is. This will afford you the opportunity to step back and take a good look for balance, symmetry, neatness, and other factors leading to a good spread that tells a good story, or leads to fast keying by another at a later date. Remember, Paul Revere's collection at the Harvard Herbarium is 200 years old, and botanists are still looking at it.

Make sure that the root and twig sections and certain types of bark are well pruned so that no projecting edges or spines will puncture the paper. Another important factor to consider is if you plan to add to the mount, i.e., spring, summer, winter, and fall, then space must be planned and specimens cut, pruned, and placed, leaving room for the upcoming collections that are to be added. At any rate, if you wish to fill the sheet, you can always have follow-up sheets with top sheet lettering, spring collection, or fall collection, and then pencil in the dates neatly and clearly under some of the specimens. Once they are laid out on the paper and it is as you like it or as your professor has directed, tape them using botanical mounting tape, or plain paper masking tape. The tape should be cut to a uniform width 1/8" to 1/4", depending upon the material to be held in place. It should be as uniform in length as possible when items are the same width or diameter. For large items such as a piece of bark or perhaps a nut or wide pod, be sure it is long enough that it does not pull free by pressure. Use short, uniform-size pieces for leaves, taking care all points are fastened or at least enough to assure the leaf will not tear or break as it dries by movement and rough handling. Be sure you have left room on the lower right-hand corner of the sheet for the label or your printed identification, as to family, species, genus, location, conditions, and other factors needed to complete a correctly keyed and identified plant.

Here is a sample of the way to mount a maple tree summer collection: First, take those sections of large twigs or branches that are about 1/2" across that have been split and well dried and properly pruned so that heart wood is showing. Place one section at the top of the herbarium paper 2" from the top and 1" in from the left hand side, with the bark showing. Tape with 1/8" sections of masking tape as to width, and about 1 1/2" long. Tape at the top and at the bottom about 1/2" from either end. These sections should be 4" to 5" long. The next section should have been pruned while green on the bark side as to offer a flat surface. This should be placed bark side down, and heart wood exposed to the viewer. Place these two pieces about 1 1/2" apart. Next, fit in a twig showing the bilateral branching of maples, and any tip color you wish to show, along with other selected twigs with desired botanical marks of identification. Make it a neat spread. Below, on the left, place a leaf of typical, good quality, and size. Tape each point section that is desirable to secure it and produce neatness. Next, if you have samara, neatly afix one of these under or to the side of the leaf. Finally, a piece of old bark will complete this unless you have the dried spring flowers. Place these items in a position that adds to overall symmetry leaving room for the label. See enclosed drawing of a maple mount.

Another method of securing the specimen to the herbarium paper is to glue it to the sheet. Many types of glues and pastes, ranging from wheat wall paper paste to mucilage have been used. Most have a tendency to dry, crack and lift up, causing the woody pieces to break the brittle leaves and delicate flowers. As for myself, I have found Elmers Glue most satisfactory.

In the case of the woody pieces, spread the glue over the flat surface that is to be pressed to the paper. Place it in the position and location that was preselected as in the tape method. Now, press it gently into place, holding it a few minutes until it takes. Wipe any glue away that has oozed out along the edges with a soft cloth, Q-tip, or some such item. Follow up with the other items, leaves, twigs, roots, bark, fruit and flowers. It is still a good practice to tape the larger and heavier pieces, or odd-shaped bulky items for a more permanent mount.

One of the oldest methods is to sew the pieces to the sheet by the means of placing knots (thread knots) on the under side of each piece with a loop over each stem or twig. Pods and fruit, seeds and bark, along with most items, were secured in this manner during the Revolutionary War days. Leaves and delicate flowers were secured with flour paste, pitch or tar. Most of these adhesives were undesirable as they caused leaves and flowers to turn colors and fade very early after mounting.

The paper slip method is as the name implies--slits were made in the paper in the areas where the item was to be secured. In the case of a twig or stem, it was slipped through the slit by lifting it gently and letting it drop back over the stem after it was inserted--top and bottom.

Today, with Saran Wrap, and countless plastic type materials, it is easy to hold seeds and some of the tiny pods and nutlets that we used to lose. Simply place them in a little plastic bag, no larger than the size you need, and staple it, or if using masking tape, secure it to the herbarium paper in the location you wish.

The label may be fancy or plain; however, the information upon it should always include at least these fundamentals at the top:

Date:

Family: Use both the Latin and the English name, e.g., Ranunculaceae, Crowfoot Family.

Genus: Ranunculas (NOTE: Genus always capitalized) L. (L--person describing it first.

Species: acris (NOTE: Species is always in small letters except in very rare cases)

Common: Buttercup

Locality: Manchester (Hillsborough County), New Hampshire

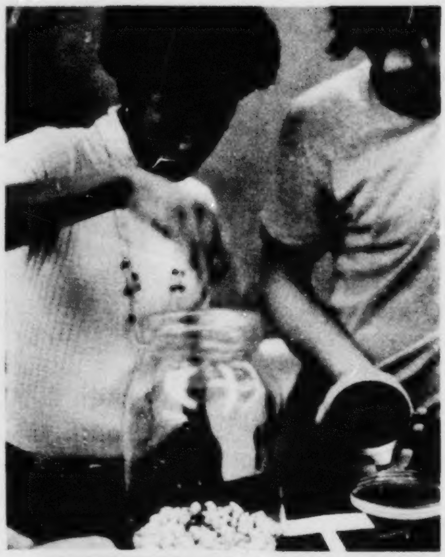
Habitat: Old field in southern part of city, near Porter Street. Partly cultivated, flat, somewhat dry.

Collector: James A. Hall

NOTE: After Genus, one always gives credit to the person who originally, or who has been given credit, for first classifying the plant. A good source to locate this information is Gray's Manual of Botany. For instance, a capital (L) stands for Carolus Linnaeus, the great 18th century Swedish botanist.

This information may be printed on a pre-made card, professional card, or neatly printed upon the hebarium sheet in the area recommended in the lower right corner.

To protect the plant, there are many methods from enclosing in plastic to Saran Wrap, or simply placing the mounted sheet in a folded newspaper (one section thick) folded in half. This is then placed in a plain jacket, usually made of newsprint. On the lower right hand corner of the jacket we repeat the information from the label in hand-written or printed form. Now, place it in your herbarium or box that is tight and free from moisture that contains a few moth balls or crystals of the same chemical.



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X

TERRARIUMS

INTRODUCTION

A. TO THE TEACHER

Making terrariums can be fun as well as an educational experience for both the student and teacher.

We seem to be in the midst of a "green revolution" and the kids really dig it! Here is our chance, as teachers, to guide the highly motivated students and captivate the interest of the "turned off kids." Making terrariums can develop skills in horticulture and landscape design in addition to gaining knowledge relative to the ecological balance of nature. The opportunity for making terrariums exposes students to a medium where creativity has no limits. It is the chance to take what Mother Nature has given us and observe, appreciate, and learn from it.

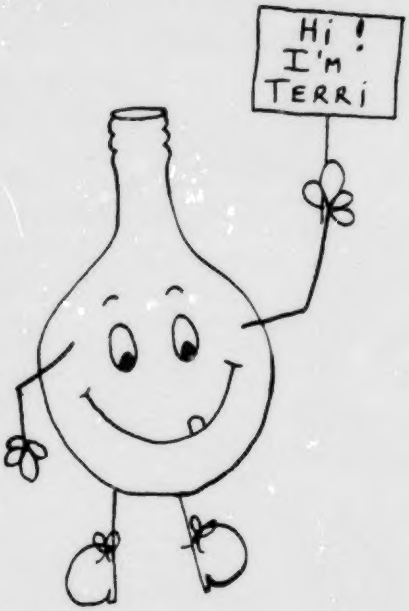
In this booklet, the students are introduced to a character named Terri Terrarium. He aids the reader with a pictorial presentation of the step-by-step procedure of making a terrarium.

How would you like to have a small stretch of desert, forest or even a swamp growing in your classroom or in your own room at home? We can do this wonder by making a terrarium! The study of living plants is an important part of every course in nature study, and the terrarium or "garden under glass" provides a place where many kinds of wild or cultivated plants can be grown successfully the year around. It provides a background for the study of ecology and the delicate balance in nature among all life.

The first terrarium was made by accident in 1829. Dr. Nathaniel Ward, a London surgeon, buried the cocoon of a sphinx moth in the soil of an enclosed jar. Shortly after burying the cocoon, a fern and some grasses sprouted from the soil, and to Dr. Ward's surprise it was a fern that he had tried to grow for years in London but could not because of the highly polluted air. The fern and grass grew for four years without additional water or fresh air. Dr. Ward had created a "balanced ecological environment" which could possibly still be growing today if the top of the container had not rusted and allowed rain to fill the container and rot the plants.

In 1832, Dr. Ward used sealed glass containers to ship plants from London to Sydney, Australia. Plants that had never before survived the trip were shipped successfully from country to country. From this accidental beginning, Dr. Ward developed a practical method of transporting rare plants from far ports in days of slow sailing ships. This led to the development of the tea industry in China and the rubber industry in Ceylon. Conservation of moisture, protection against sudden changes of temperature, and provision for light are the basic principles of a terrarium.

Now that we essentially know what a terrarium is, what is involved in making one? Let's meet Terri-Terrarium!



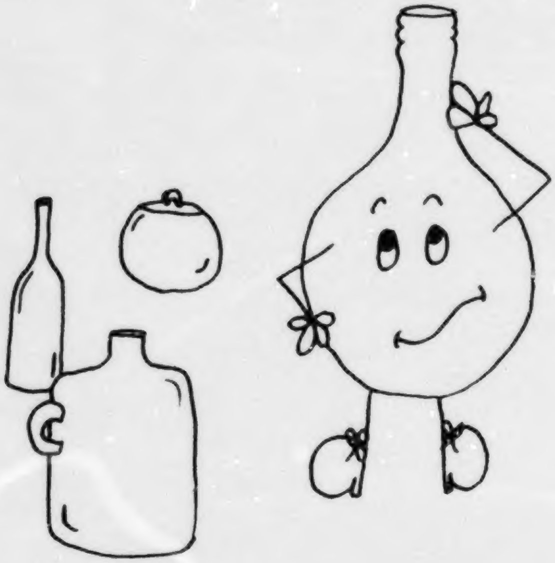
B. Procedure

Select Container

Most people begin making a terrarium by selecting a container. It may be selected to fit a particular space and location in the home or school or because of the size of plants that are preferred, or because of the availability to students of certain containers. Some containers that have been used in the classroom are a brandy snifter, a leaky or discarded aquarium, a wine bottle, a fish bowl, a fruit jar, a plexiglass cube, an antique medicine bottle, a canister, a cracker jar, a water bottle, etc.

If the container you have selected has an opening which is too small to work through, you have one of two choices: use special tools to help place the plants and materials in the bottle or cut the bottle, arrange the plants and materials, then glue the bottle back together with epoxy glue. For use in the classroom, students prefer to work with a bottle that has been cut. Refer to diagram 1 on directions for cutting a bottle.

A clear glass container is best, but many times people will insist on choosing a colored container. Remember, the plants must have light and colored containers cut down on the light supply. If you do choose a colored container try to select one that

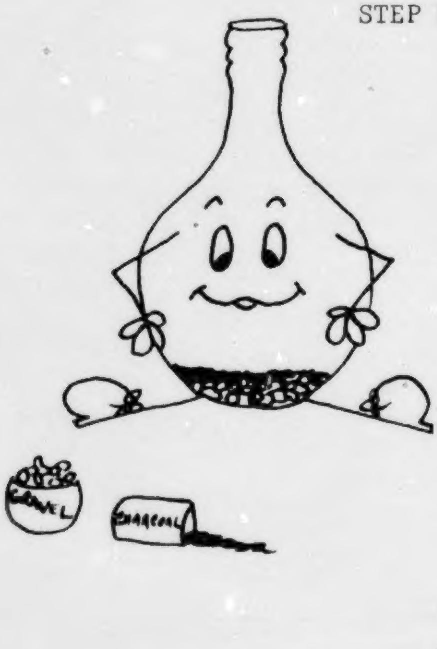


is only slightly tinted and select plants that require only a small amount of light. After the container is selected it should be thoroughly cleaned and dried so that soil and charcoal do not stick to its sides. Remember that the size of a container will regulate the size and number of plants that can be used.

Prepare Drainage Material

Since a terrarium usually does not have drainage holes, gravel and activated charcoal need to be used. (Ordinary limestone used for lawns may be used with the charcoal, or, if charcoal is not available, limestone may be used in place of the charcoal.) The charcoal is needed to keep the soil sweet or in other words, prevent the soil from becoming too acid and will help eliminate odors within the terrarium. Charcoal is not needed in open terrariums (containers without covers) such as those made using succulent plants or cacti.

STEP 1--DRAINAGE MATERIAL



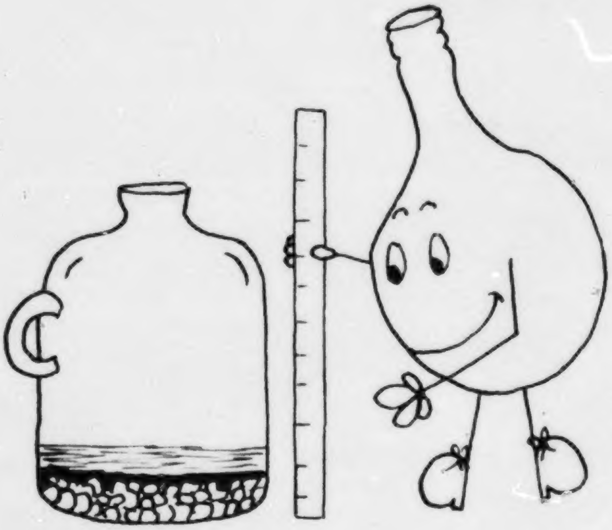
Here is how you should prepare the drainage material.

1. Add approximately 3/4 inch of gravel to bottom of the container.
2. Add 1/4 inch of activated charcoal.
3. You may, instead, mix these two ingredients together for a total of 1".

Prepare Proper Soil Mixture

You can either purchase a soil mixture or mix your own. There are many commercial soil mixtures but always make sure the one you choose has been sterilized and is weed free. These mixtures can be purchased at almost any garden center, nursery, or at many department stores' garden centers. Most of the commercial soil mixtures are for tropical or foliage plants. Therefore, if cacti and succulent plants are being used, add 1/4 to 1/2 parts of sand to the mixture or you could use most of the sandy soil that the cacti plants are purchased in. To make your own soil mixture, use approximately one part vermiculite, one part peat moss and four parts sterilized top soil. This is also an ideal soil mixture for general planting of almost any plant.

STEP 2--ADDING SOIL MIXTURE



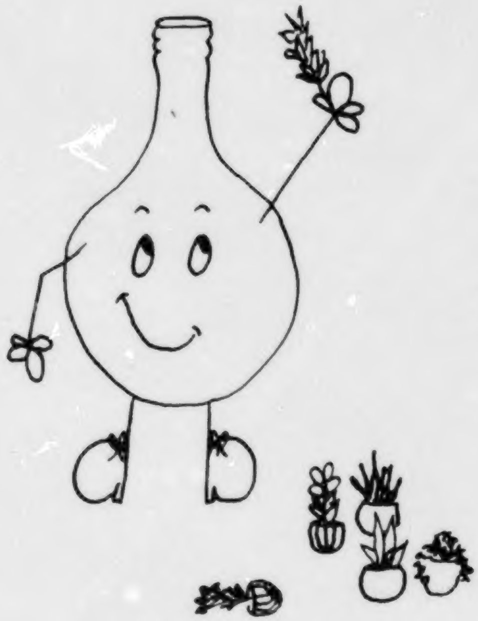
1. Add the dampened prepared soil mixture on top of the drainage material. Use 1 to 3 inches of mix or approximately an inch of soil per foot of container height.
2. The amount of soil will vary according to the size of the container but normally the soil and drainage material will occupy approximately 1/4 the height of the container.

Refer to Diagram 2 for completed drainage and soil system.

Now you are ready to select the plants. Remember that the plants selected for a container should be compatible relative to light, soil, temperature and humidity (water need) requirements. Be careful to select plants that have the same light requirements. This will depend upon where you plan to place your terrarium after it has been completed. A list of plants and their requirements is provided in Tables 1-3 and Figures 1-76.

Most of your plants can be obtained at any of the local florists. For the thrifty buyer, fine plants can be purchased from supermarkets and department stores. However, if any problem arises over plant selection the local florist is the most helpful and knowledgeable. Don't be afraid to ask questions.

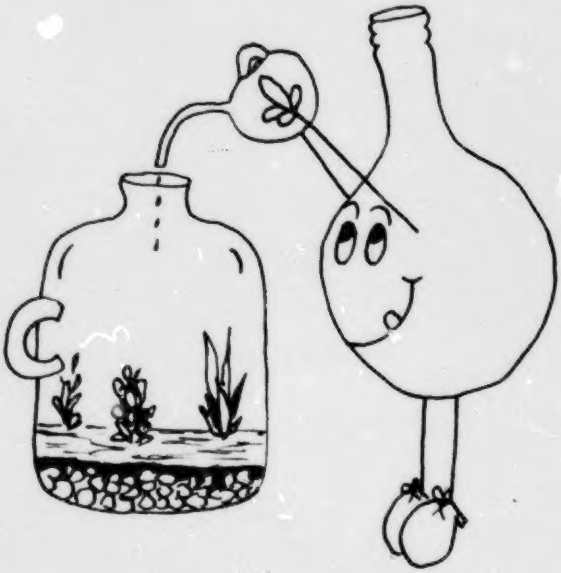
STEP 3--ADDING THE PLANTS



1. Remove the selected plants from their containers by gently tapping the side of the container against a table corner to loosen the plants' roots. Now, gently free the plant from the base out of its container.
2. Carefully remove the excess soil by tapping it with the hand.
3. Dig a small hole in your terrarium container and place your plant in the hole.
4. Replace the soil and press it firmly around the plant.

Continue this process until all the plants have been inserted beginning with the larger plants and ending with the ground cover. Avoid, if possible, having plants touch the side of the container as it may cause "damping off" (a plant disease). It is suggested that two or three plants are a sufficient number to place in an average size container (gallon size). Such objects as rocks, tree bark, shells, or ceramic figures can be added. Remember, this terrarium is your own creation. Use your imagination and creativity! However, let us not forget that a terrarium should also represent a natural environment in miniature. Plants should now be cleaned of soil that might have gotten onto their leaves during the planting process.

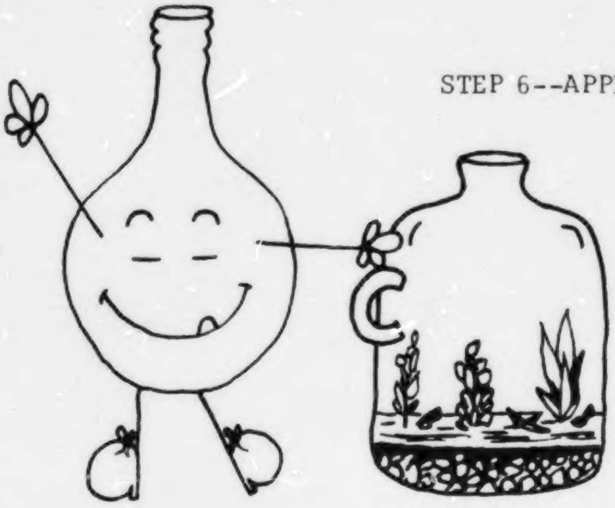
STEP 4--WATER



Water the terrarium sparingly with a long-neck watering can or a mist sprayer. DO NOT OVERWATER. It is probably better to underwater than to overwater a terrarium. You should use either rain water, spring water, well water, distilled water, or tap water that has been let stand overnight for your terrarium. In a closed terrarium, the chlorine found in many city water supplies may prove harmful. Leaving tap water out to stand allows the chlorine to turn to a gas and evaporate.

STEP 5--CLEAN

Clean the container's inside walls with a piece of soft cloth, being careful not to dislodge the plants.



STEP 6--APPLYING THE COVER

The last step is to apply the glass or plastic top, a stopper, or food wrap, to the container. The finished product should be a very beautiful, well appreciated terrarium.

C. Care of Your Terrarium

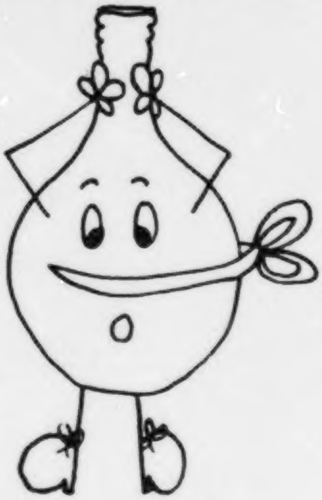
Proper lighting usually called light intensity is essential. Light intensity is measured in foot-candles. Most homes have less than 150 foot-candles. Therefore, select a window or area that will give the proper number of foot-candles for the plants growing in your terrarium. Most house plants prefer approximately 500 foot-candles. A southern exposed window might have 500 foot-candles in the winter but 1,000 foot-candles in the summer, so move the terrariums for proper light.

Plants in terrariums sometimes languish because of too little light; but perhaps the chief killer of terrarium plants is too much heat. A closed glass container is a heat trap because light rays pass through the glass almost instantaneously while heat escapes through the same glass much more slowly. Since most of the light rays turn to heat when they hit a dark solid surface, the temperature inside a closed terrarium may be very hot when the air outside is quite cool. REMEMBER: NEVER PLACE A CLOSED TERRARIUM IN DIRECT SUNLIGHT.

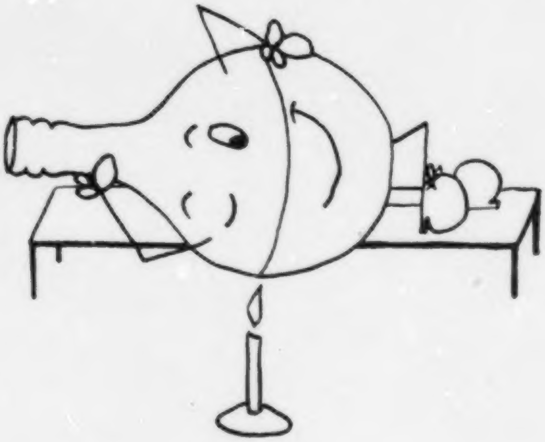
Diagram 1

D. DIRECTIONS FOR CUTTING A BOTTLE

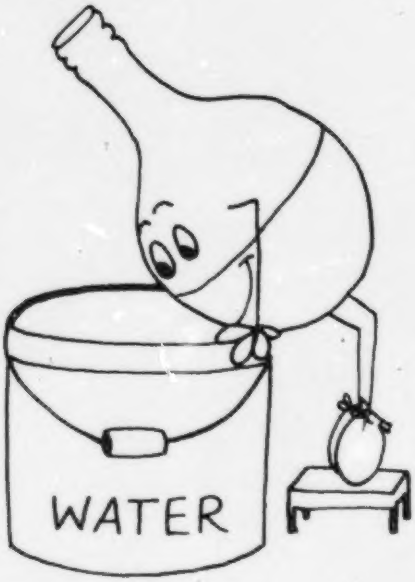
1. Scribe a line with a bottle cutter.



2. Heat the scribed line with an alcohol lamp or Bunsen burner for 1-2 minutes.



3. Quickly submerge in a bucket or pan of cold water.



4. The bottle should crack apart on scribed line. If it does not crack, repeat steps 2 and 3.

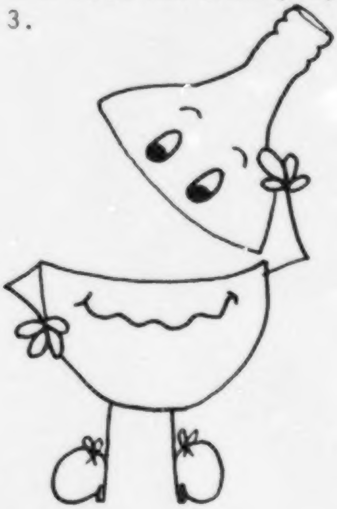
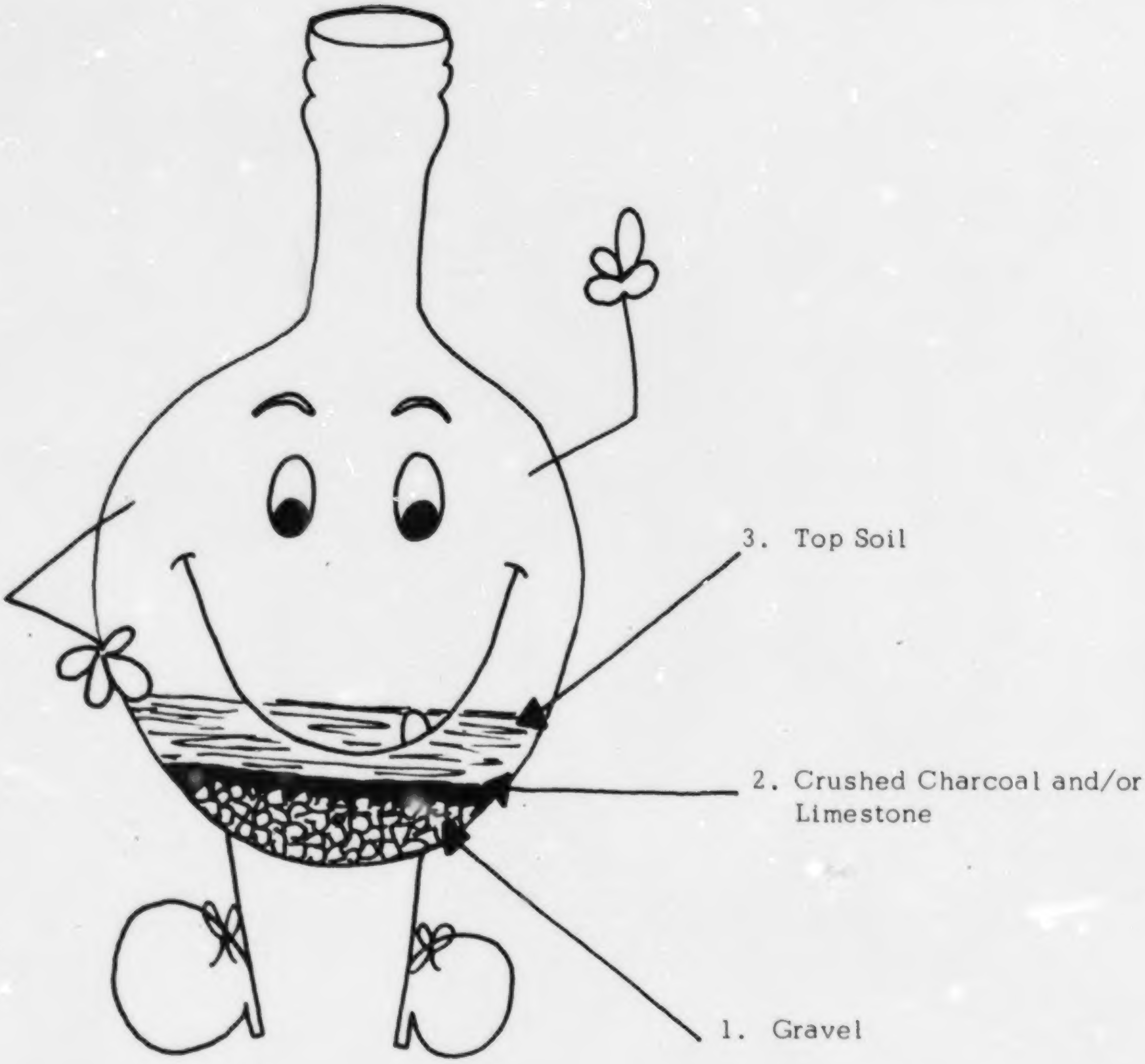


Diagram 2

DRAINAGE AND SOIL SYSTEM

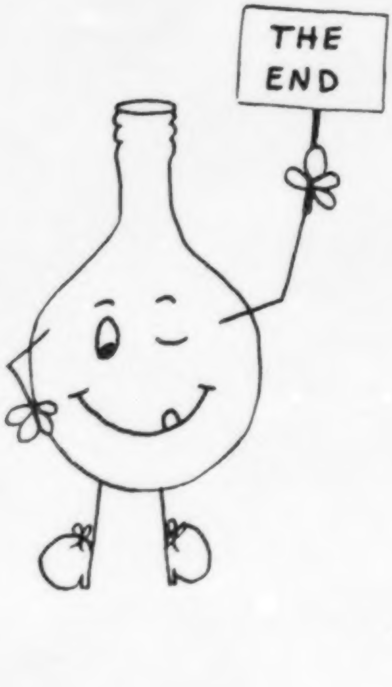

3. Top Soil
2. Crushed Charcoal and/or Limestone
1. Gravel

Note: Colored Gravel may be used on any of the layers below the top soil.

Watering

Water your terrarium very carefully. Closed or open bottle terrariums may not need additional water. Don't worry about the container misting over each morning. Simply wait an hour or two and it will clear up by itself if the moisture balance is correct. If the moisture balance is too high, leave the cover off for a day. Consistent success has been seen in those terrariums where there is a small opening. However, if they are sufficiently sealed, the terrariums may form their own water-cycle. Open terrariums will require small amounts of water. Add water when the plants begin to wilt slightly or the soil begins to turn light-colored. Remember, DO NOT use water directly from the tap without letting it stand overnight, unless it is rain, distilled, or well water.

If you follow these instructions, you should have a beautiful terrarium that you can be proud of.



XI

AIR POLLUTION

A. Introduction

We hear a lot of talk these days about pollution of our environment. Some people say we are heading for a major ecological disaster and others say that ecologists are far more concerned than is necessary. We are not going to attempt to decide who is right and who is wrong; we are going to present information and experiments that, hopefully, will allow the student to decide for himself, at least in the area of air pollution.

Our atmosphere is a large sea of gases. It contains the gas we breathe--oxygen, the gas used by plants is photosynthesis, carbon dioxide, and many other gases, some of which protect us from harmful rays from the sun, and some which appear to serve no useful purpose to us at all. Table 1 shows the relative amounts of some of the gases found in the atmosphere.

TABLE 1

Composition of Clean, Dry Air

Gas	Per cent by Volume
Nitrogen (N_a)	78%
Oxygen (O_2)	21
Argon (Ar)	0.94
Carbon Dioxide (CO_2)	0.03
Helium (He)	0.01
Neon (Ne)	0.01
Xenon (Xe)	0.01
Krypton (Kr)	0.01
Methane (CH_4)	trace
Ammonia (NH_3)	trace
Hydrogen Sulfide (H_2S)	trace
Carbon Monoxide (CO)	trace
Nitrous Oxide (N_2O)	trace

Also present in the atmosphere are water vapor, dust, and volcanic ash. These are all natural substances, present as a result of natural processes. Man has done many things which tend to upset these natural processes and change the composition of the atmosphere. We call this pollution. Someone once defined pollution as substances present in the wrong concentration in the wrong place at the wrong time. Using this definition we can see that man can pollute the atmosphere by either changing the relative amounts of substances naturally present, or by adding new substances.

What Does Pollution Do?

Pollution has many effects on humans, plants, animals and inanimate objects. According to a group of scientists in California, there may be a connection between some types of air pollution and cancer. Air from the atmosphere over a city was added to living cells in a tissue culture. Some of the cells were stimulated by the pollutants to react in the same way that they react to a carcinogen.

Air pollution is killing trees and bushes in cities where there is a large amount of automobile exhaust. Buildings are deteriorating at a rapid rate due to acids in the atmosphere. Smog, trapped near the surface of the earth by a temperature inversion has caused deaths, particularly among the elderly or those with respiratory problems. These are just some of the results of pollution.

Is Air Pollution a New Problem?

England, in 1306, passed a law against air pollution--they banned the burning of coal while Parliament was in session. It has been only recently, however, that air pollution has become an extremely serious problem. The large number of factories and automobiles in modern society have greatly increased the amount of pollution. "The first recorded air pollution disaster in the United States occurred in Donora, Pennsylvania, in 1948. A heavy fog settled over the city and did not lift. Industrial waste kept pouring into the atmosphere, and day turned to night. Seventeen people died and about 5,000 became ill.

"Four years later, from 4,000 to 5,000 people died in a single week in London as a result of the fog. In 1953, over 200 New Yorkers died from air pollution in a period of a few days."[2]

Where Does Pollution Come From?

"Automobiles contribute oxides of nitrogen and carbon monoxide to the air. In New York City alone about 10,000 tons of their compounds are given off each day. Factories also put many pollutants into the air. Hydrofluoric acid, sodium and calcium fluorides, compounds of arsenic, chlorine, sulfur dioxide, sulfuric acid, hydrochloric acid, and compounds of zinc and lead are just a few of the possible substances."[2]

Searching for Pollutants

There are seven classes of air pollutants. They are: fine particles, sulfur dioxide, carbon monoxide, smog reactants, total oxidants, radioactive pollutants and other pollutants (CO_2, etc.). We are going to look at some experiments that will further our understanding of the atmosphere and show whether some of these pollutants are present in your community.

B. Activities

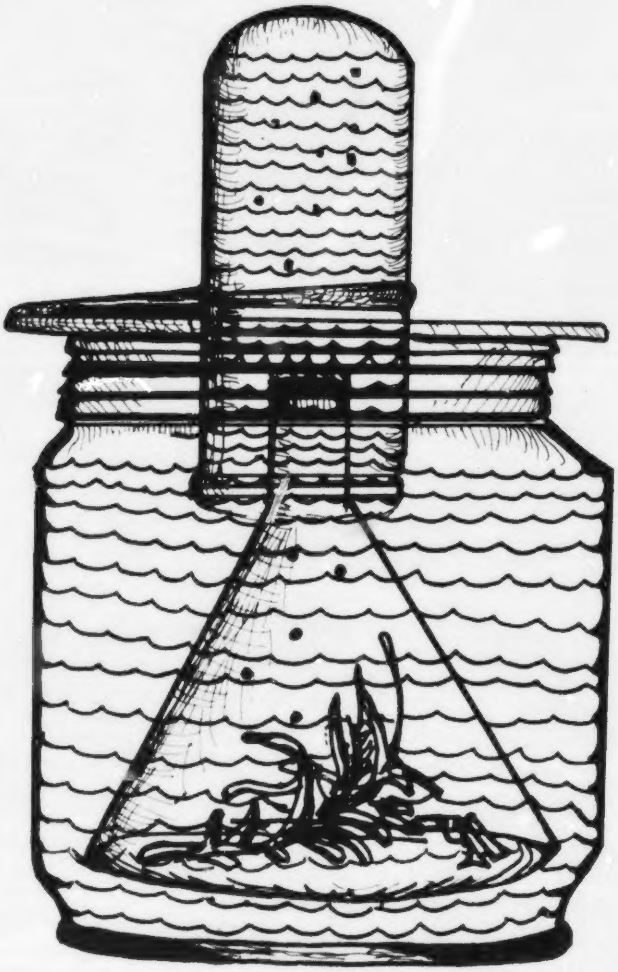
Experiment 1--Oxygen from Plants--Photosynthesis[3]

Photosynthesis is the process by which green plants change water and carbon dioxide to food and oxygen, using energy from the sun. This experiment will show that oxygen is really one of the products.

Materials

Large, wide-mouth jar
Funnel
Wood splints
Test tube
Green plant that grows under water (Elodea)

Fill the jar with water and place the plant in it, covering the plant with the inverted funnel. Fill the test tube with water and invert it over the funnel, being careful not to allow any air to enter the test tube. Clamp the tube securely in place and set the whole apparatus in sunlight. (See Fig. 1) Gas bubbles should begin to collect in the test tube. When the tube is filled with gas (about 24 hours) light the splint and blow out the flame, leaving the splint glowing. Remove the test tube and insert the glowing splint into the tube. The splint should glow brighter and perhaps even burst into flame. This is the standard test for oxygen



(Fig. 1)

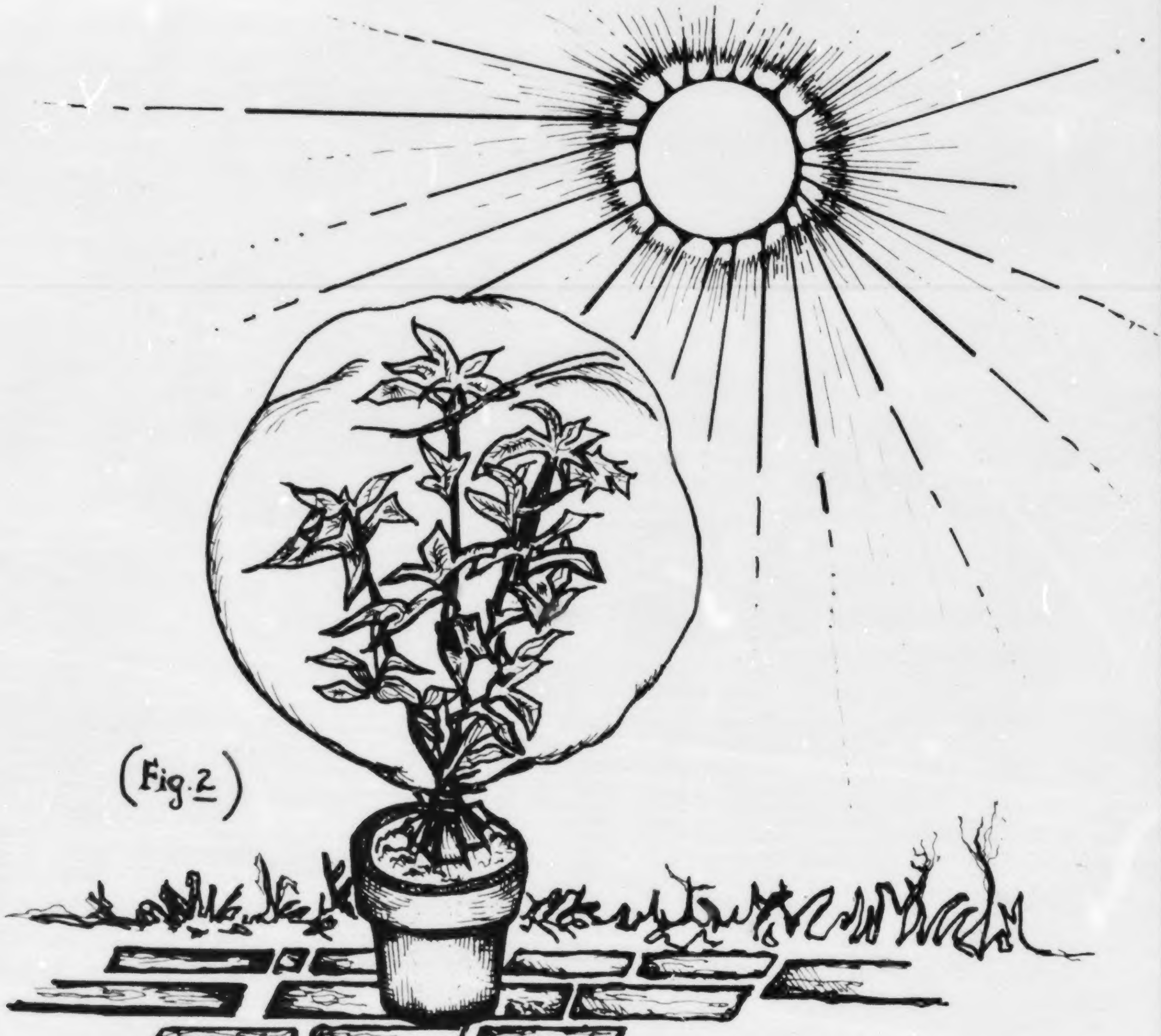
Experiment 2--Water from Plants--Transpiration[3]

Plants not only give off oxygen as they grow, they also release water into the atmosphere in fairly large amounts. A birch tree, for example, releases as much as 70 gallons of water a day. This process of water release, called transpiration, can be shown in the following way.

Materials

Potted plant	Large, clear plastic bag to fit over plant

Place the bag over the plant, allowing the bag to puff out as much as possible, and tie the bag around the plant, the base of the stem (being careful not to cut the plant). (See Fig. 2) You may have to support the bag to prevent it from pressing down on the plant. Place the plant in sunlight for a few hours and observe.



(Fig. 2)

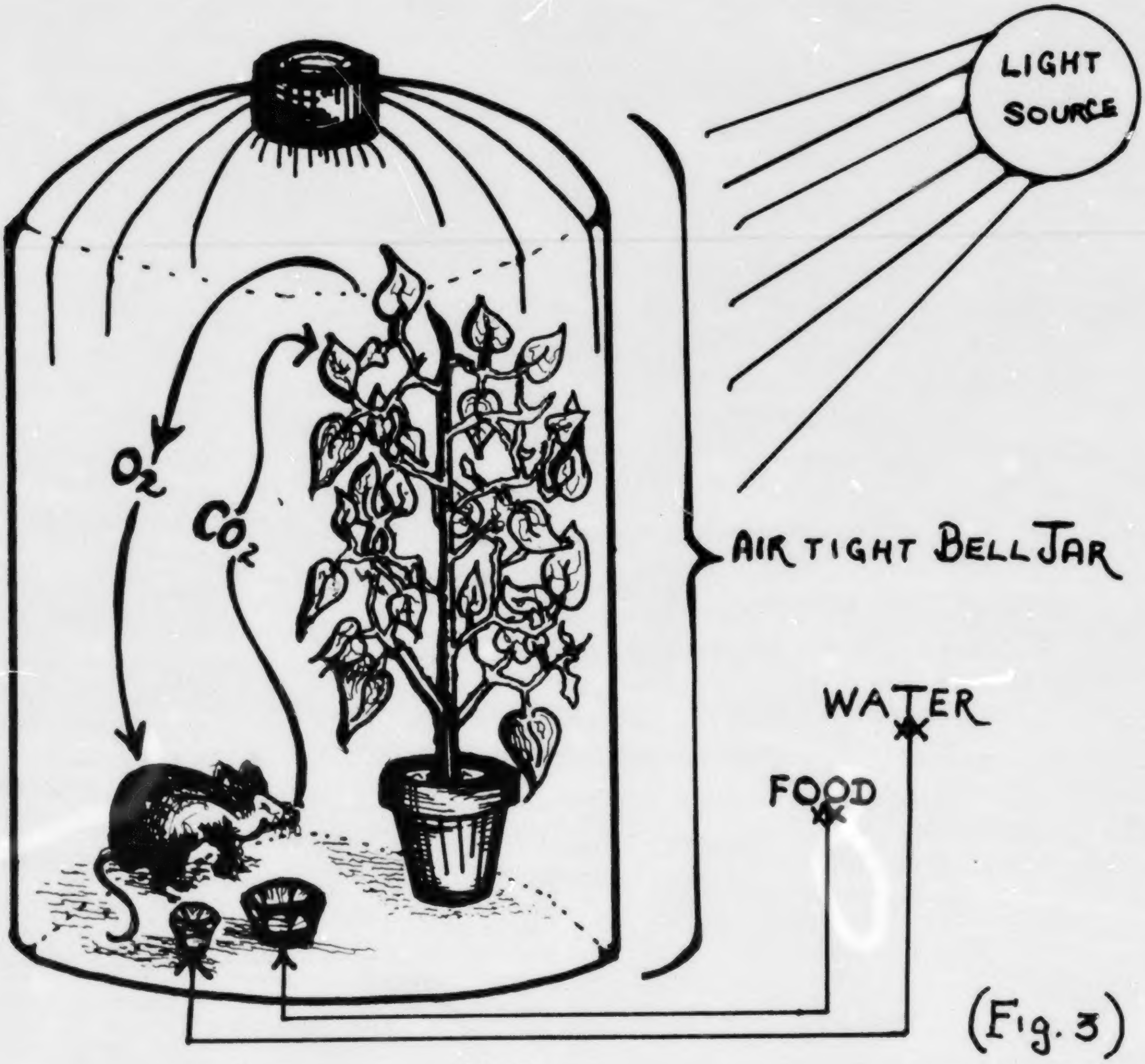
Experiment 3--Exchange of CO_2 and O_2 by Plants

We have previously stated that plants use CO_2 and release O_2 during the process of photosynthesis. We shall show this process with this experiment.

Materials

Large potted plant (green)	Large bell jar
Mouse (small)	

Place the plant and the mouse under the bell jar and seal the bell jar to make it air tight (be sure to provide the mouse with food and water). (See Fig. 3) Place the bell jar in sunlight or a good artificial source of light. The plant will release enough oxygen to allow the mouse to breathe and the mouse will provide carbon dioxide for the plant to use for photosynthesis.



(Fig. 3)

Experiment 4--Particulate Material in the Air[4]

Much of our air pollution consists of particles that are carried by the wind and settle at some distance from their source. This experiment will allow us to measure the amount of particulate materials in the air.

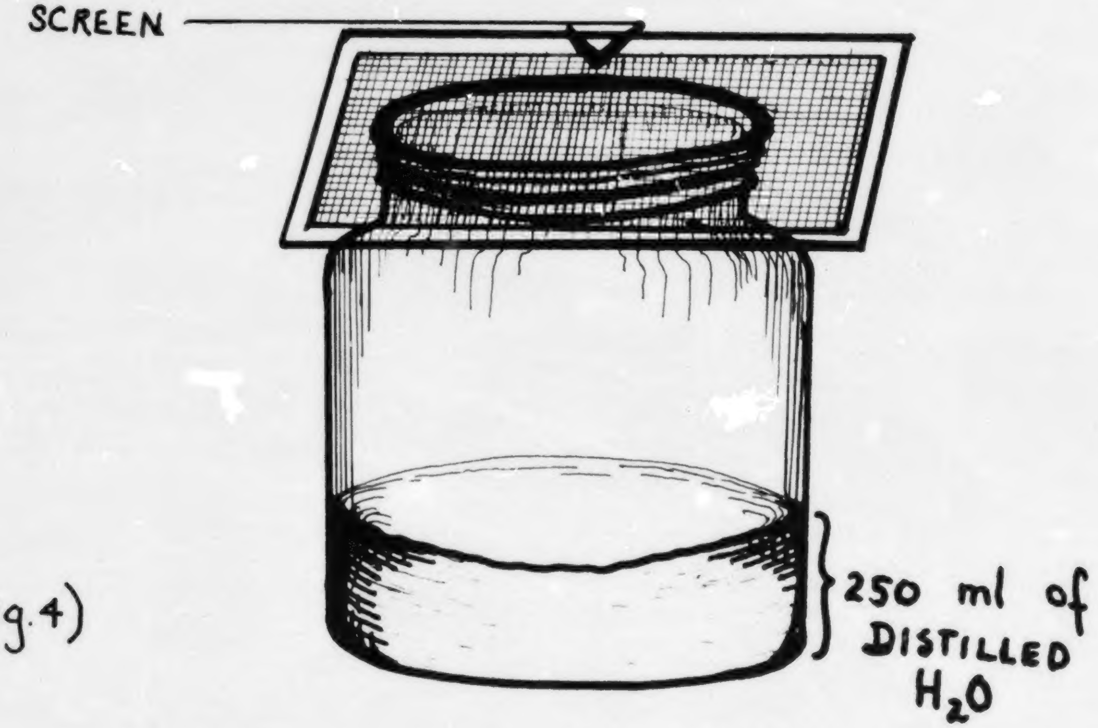
Materials

One gallon size wide-mouth glass jar	Wire screen to cover top of jar
250 ml of distilled water	Balance

Fill the jar with the distilled water and cover with the screen to keep out insects. (See Fig. 4) Mark the water level with tape or a glass marking pencil. Place the jar outdoors in an exposed place about 5 feet above ground where no unusual air currents are present. Add distilled water as needed to replace water lost by evaporation. Rain or snow are not a problem as long as the jar does not overflow. Leave the jar in place for 30 days.

At the end of 30 days put the 250 ml of water into a beaker that has been weighed to 0.1 mg. Be sure any particles adhering to the inside of the jar are transferred to the beaker. Allow all of the water to evaporate (a drying oven can be used if available). When completely dry, weigh the beaker and contents and calculate the weight of the solids.

Use the formula $0.785\ d^2$ to calculate the area of the jar exposed to pollutants (d equals diameter of jar) to nearest 0.1 cm. Calculate the solid pollution in mg/cm^2 per 30 days.



(Fig.4)

Experiment 5--Nature of Particulate Air Pollution[4]

Materials

Number of clean glass microscope slides	Microscope
Immersion oil, vaseline or similar substance	Key to identify particles, if available

Spread a thin coat of oil or vaseline over about 3/4 of 1 side of each slide. Place the slides, oiled side up, in various locations that are potential sources of pollution. The slides should remain undisturbed for 25 hours.

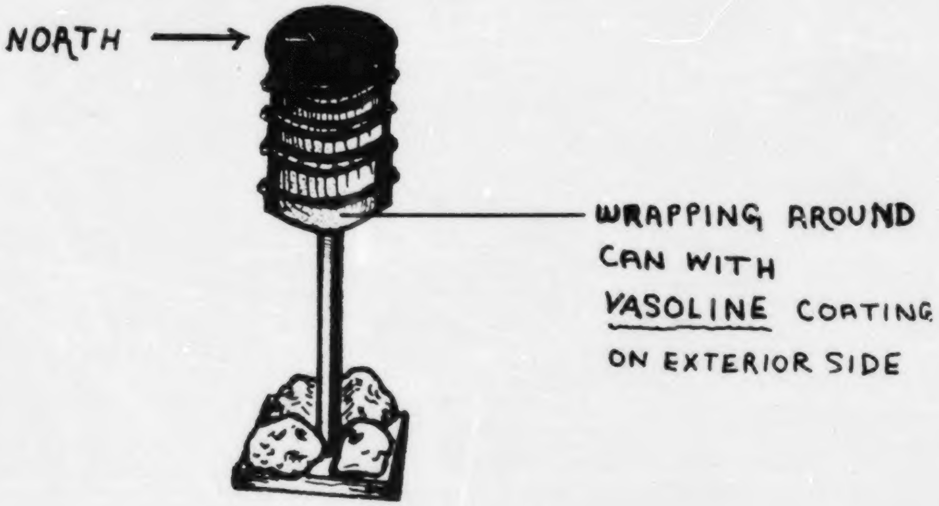
Examine the slides under a microscope. Find out what the area of the field of vision is under the microscope and record it. (1) Count the number of particles in the field of vision for each of three different areas on a slide and calculate the average number of particles per area. (2) Estimate the size of the particles in relation to the diameter of the microscope field and calculate the per cent of area covered by each size particle. (3) Use an identification key if available to list the types of particles present. (4) Determine such things as relations between type of particles and collection area, methods and costs of controlling this pollution, effects of weather and seasons on type and amount of particles collected at each location, etc.

Experiment 6--Effects of Wind on Pollution[3]

Materials

Large coffee can or juice can	White paper or cardboard to fit around outside of can
Vaseline	Wood base 1 1/2' X 1 1/2'
Wood pole 4 ft. long	

Mount the can on the pole open side down. (See Fig. 5) Tie the paper or cardboard around the can and coat it evenly with vaseline. Mark an arrow on the top of the can to indicate north. Place the apparatus as high as possible (on a flat roof is good) and leave it undisturbed. Check every few days to see if more particles come from one direction than another.



Experiment 7--Effect of Air Pollution on Nylon[3]

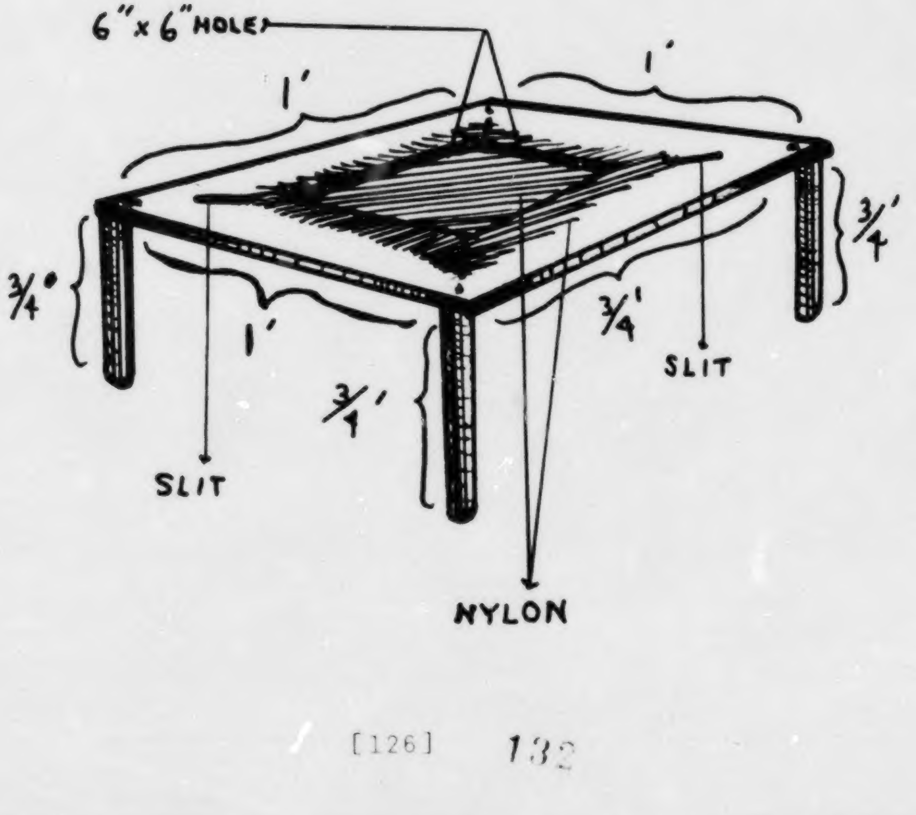
Evidence has been obtained that some types of air pollution cause damage to women's nylon stockings. This experiment will show if that is a problem in your community.

Materials

Discarded nylon stocking
Wood pole 3' long (broomstick)
Stiff cardboard 1' X 1'
Magnifying glass

Make a hole 6 inches X 6 inches in the center of the cardboard and smooth the edges. Cut the wood pole into 4 equal pieces and nail the pieces to the corners of the cardboard to form legs. Cut an 8" piece of nylon from the best section of the stocking. Make a slit in each corner of the cardboard and work the ends of the nylon into them. Stretch the nylon just tight enough to remove any wrinkles.

Examine the nylon with a magnifying glass and record any holes or broken threads you see. Place the sample where it will remain undisturbed (outside) and inspect it once a week for new holes or broken threads. These are caused by a substance called acidic soot.



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XII. THE PHOTOGRAPHIC PRESENTATIONS

A. Introduction

A photographic presentations unit is one of the most versatile tools a class can utilize. Photography is a dynamic learning tool, and also an interdisciplinary one. A photograph can stop time and hold one second in isolation for eternity. It can capture an everyday event and give it a new and different perspective. In our society, the number of cameras owned by amateur photographers who range in age from 8 to 80 must approach the number of cars traveling on our highways. This is a learning resource that cannot be ignored.

A simple snapshot, slide transparency, or strip of home movie film, coupled with a narrative that could range from a scientific equation to poetry, can become one of the most striking ways of getting a point across or telling a story. Webster's Dictionary defines description as "the act, process, art, or technique of describing; picturing verbally...." Many times we all have been in a situation where, the more we tried to explain something, the more muddled it became. Either words do not convey the picture we wish to present, or we cannot find the ones that will do the job. A photograph will remedy such a situation.

With the widespread interest in environmental concerns today, photographic presentations about the conditions of our water, air, and soil are in great demand. Through a well-researched presentation, community awareness of the vibrant, living world--both good and bad--outside its door will be increased. Students involved in such a project gain great self-satisfaction from the recognition and praise they receive as a result of their labors. There are so many different details that go into the construction and preparation of such a show that all levels of students, from the so-called under-achiever to the honor student, will find a place in the overall scheme. Such activities also bring key issues closer to the student and assure us of better, more informed voters in the future, and of young people with a keener sense of right and wrong today. They allow the students the opportunity to extend themselves as far as they think possible. The extent often surprises the student greatly.

The idea of a slide or movie presentation will amost always spark the imaginations of students. To further fuel the fires, see if there is a student presentation unit near to you that you can have come and present a show during class time. The ideas and techniques your students pick up from this experience will show up in their own presentations. The question of topic will arise. To settle this debate, the formation of topic teams will speed things. Ask each team to decide on a topic, research it, and present the argument for making this the topic of the show to the class. Mention that the topics that don't make it for the first presentation may be chosen for subsequent efforts if this first venture succeeds. The list of topics could touch on sociological themes, beautification projects (such as a "Before and After" approach), water pollution, patterns of the skyline, air pollution, graffiti, garbage disposal, etc., etc. Be sure that each project can be shown through local sites that may be photographed with ease. Let the topic teams give their proposals, and let the group decide.

B. Material Inventory

With the topic decided, begin with an inventory of available audio-visual equipment. Consult your school A-V director or club advisor to inquire about loans of cameras. Also have the students secure any available cameras from home. For slide presentations, 35mm Single Lens Reflex cameras are probably the best cameras as far as versatility goes. They afford excellent focus and many can handle a variety of lenses and filters. If a 35mm is not available, Instamatic ^{tm} sized 126 cameras will give good results. The new varieties of pocket-sized cameras can be used, but remember that these slides will be much smaller than a 35mm or 126 slide, and may need a different kind of projector. If movies figure into your plans, try to get a Super 8 system. Regular 8mm film must be threaded into the camera from a reel, and must be removed and flipped over halfway through filming due to the fact that only one-half the width of the film is exposed at once. After developing, the film is split down the middle and spliced together end to end to give a continuous length. Super 8 is one-half again as wide as regular 8mm film and provides a much brighter picture. It comes packaged in a 50 foot cassette that is simply dropped into the camera to load. No flipping of the film is required. Super 8 film must be run through a Super 8 projector and likewise for regular 8mm film. There are some projectors that are interchangeable. A movie presentation will be composed of many fragments of film spliced together. Thus be sure your class will be able to use a viewer/splicer. This device allows the film to be seen in a small television-like viewer, then cut at a precise angle between the small holes along its perimeter where the film advance gears of the camera and projector take hold. This precise angle allows another strip of film to be taped to this one and assures no interruption when viewed later on a projector. Let the students get hands-on experience with all the equipment and encourage those with some know-how with certain pieces to train the others.

Since this project will involve purchase and processing of film, you will have contact with a local photographic dealer. Contact several concerning prices and then "talk turkey" with one. Isk if there is a reduced rate because you are a school group. If you plan many pictures, ask about quantity discounts. Ask if the dealer could possibly come and address your class about proper photographic technique. Mention that this project is a service to the community, that the students want to hear from someone with extensive photographic experience, and let him realize that if your students make a successful presentation this time, it could lead to further projects of that kind in the future, and could mean an increased appreciation of photography outside of school--meaning future customers. Ask him to go through the most common mistakes made by amateur photographers and to recommend helpful books on the subject. Many film manufacturers publish "How-To-Do-It" books.

C. Site Selections and Photography

You are now ready for the first photographic field trip. Figure out where in your community are the scenes that depict the story you want to tell. Make sure there will be no difficulty in getting at the sites you and the class have picked. Ideally there should be several sites to be photographed, and the cameras should be divided accordingly. Determine who will man the camera teams, and work out a rotation schedule for the cameras. If a student wishes to use his or her camera exclusively, don't worry.

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A camera will now become a precious instrument to them, rather than just a hobby toy to be used during the holidays. At the site, don't be afraid to experiment. Take several views of your subjects. Get the film off to the processer as soon as possible. The students eagerly await the pictures. Opinions expressed while waiting for the film range from "I'll take the best pictures" to "I don't think mine will come out." Thoroughly review the techniques the dealer discussed so they will be again fresh in the students' minds. Once you have the pictures, go over them with the class carefully. Point out errors that are visibly apparent, then go back and criticize on the basis of light angles, focus, depth of field (thickness of the in-focus zone), and shutter speed and f-stop if applicable. Call in your dealer and show him the pictures. Listen to his critique as well as those of others. If there are any faculty member with a good knowledge of photography, ask him or her to be an advisor to the project.

D. Building the Display Units

Since you are familiar with the general layout of the areas you will be photographing and you know the sites that will be used, start thinking about the general sequence and arrangement of your show. Work out a storyboard--a series of 4 in. X 5 in. file cards divided in half with a simple line drawing on one half representing the scene to be photographed, and a preliminary narrative for that scene on the other half. This makes the best use of time and film when in the field. Again, do not be afraid to experiment. What you have on your storycard is not necessarily what will be on your presentation. If a better technique or shot occurs to you in the field, then by all means use it. Often with careful planning, a small number of slides necessary to produce a high quality presentation will be small. The same will hold true from a movie documentary with respect to footage. When the group decides the number of slides or the footage of film is enough for the purpose, then begin the final selection of "prime footage"--the slides or movies to be used in the actual presentation. This MUST be a group effort with total participation across-the-board. In this way, it truly becomes a class project. Also, revise your storyboard to compensate for any additional scenes taken in the field. This is the best time to decide on the final order for presentation. In a slide presentation the order can still be changed but in a movie, once the film is spliced together, it is not easy to resplice and change the order. Start formalizing the narrative at this time, being careful not in include too many formal terms without a careful explanation of each. Make each point clearly. Don't beat around the bush. Decide how long each scene should last, and whether or not a sentence or two of explanation is necessary. If you have a particularly good, vibrant, striking photograph, arrange another slide before it to make your point, and then flash this scene on the screen and say nothing--let the slide make the point itself.

E. Preparation for Oral Presentations

Speakers must be selected. Most of the extroverts will jump at the chance to speak while most of the introverts will shy away from it. A possible answer to this problem is the formation of presentation teams. Compose these of a speaker (the extrovert), the speaker-trainee (introvert), and a support member to handle screening, projector, and extension cords. Rotate speakers to allow everyone a shot at a presentation. Work with the class on lecture technique. Stress the clear pronounciation of each word. Perhaps a local speech teacher could talk with the class about staging and voice projection. Compile all of the components of the presentation and begin rehearsing--with special emphasis on timing. If, in a slide presentation, one member changes the slides while another speaks, their timing is very important. If the speaker misses a cue and starts talking about the wrong slide, disaster could result. In a movie narration, the speaker must know the scenes precisely so as to use particular scenes as cues to begin another sentence. Encourage comments and criticisms from the project members and advisors.

F. Test Run and Final Preparation

Try the show out on another class. This atmosphere will give the students a bit of confidence and let them show some pride. The questions asked by their friends will probably be the toughest they will run up against. Although they should be prepared for any contingency, don't discourage them from answering with a simple "I'm sorry, I don't know." The next step is to contact area schools to inquire if they would like to see your show. Younger children are often ecstatic at receiving a group of older students, and the presentation team gets a feeling of the inner workings of education because in a sense, they are the teacher for a while.

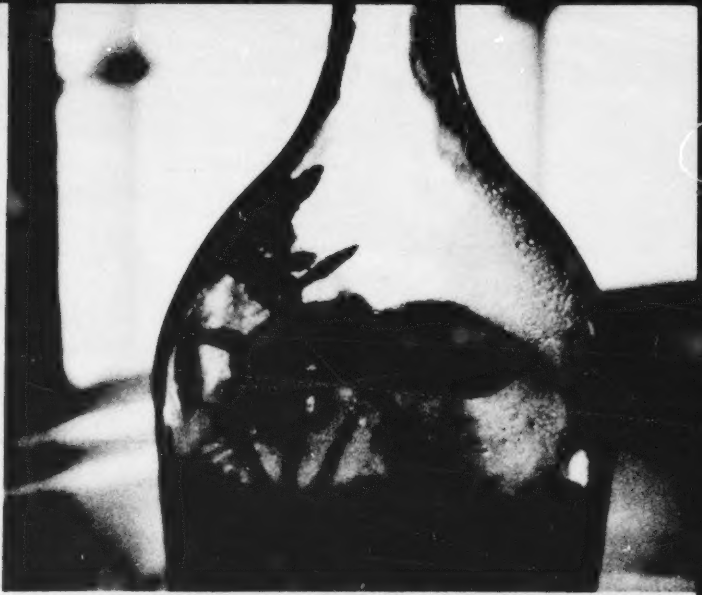
With several school shows under their belts, the presentations unit could go to outside organizations. Service clubs, women's and men's organizations, Lions, Elks, Rotary Clubs, and Kiwanis are always looking for groups willing to give presentations; a short synopsis of the narrative and a telephone number is usually sufficient to inform the clubs of what the presentation will offer. Your local Chamber of Commerce can usually supply you with the necessary addresses. Since the students will be a bit experienced by now, write up a short introduction to tell the audience where they will be going in their film journey.

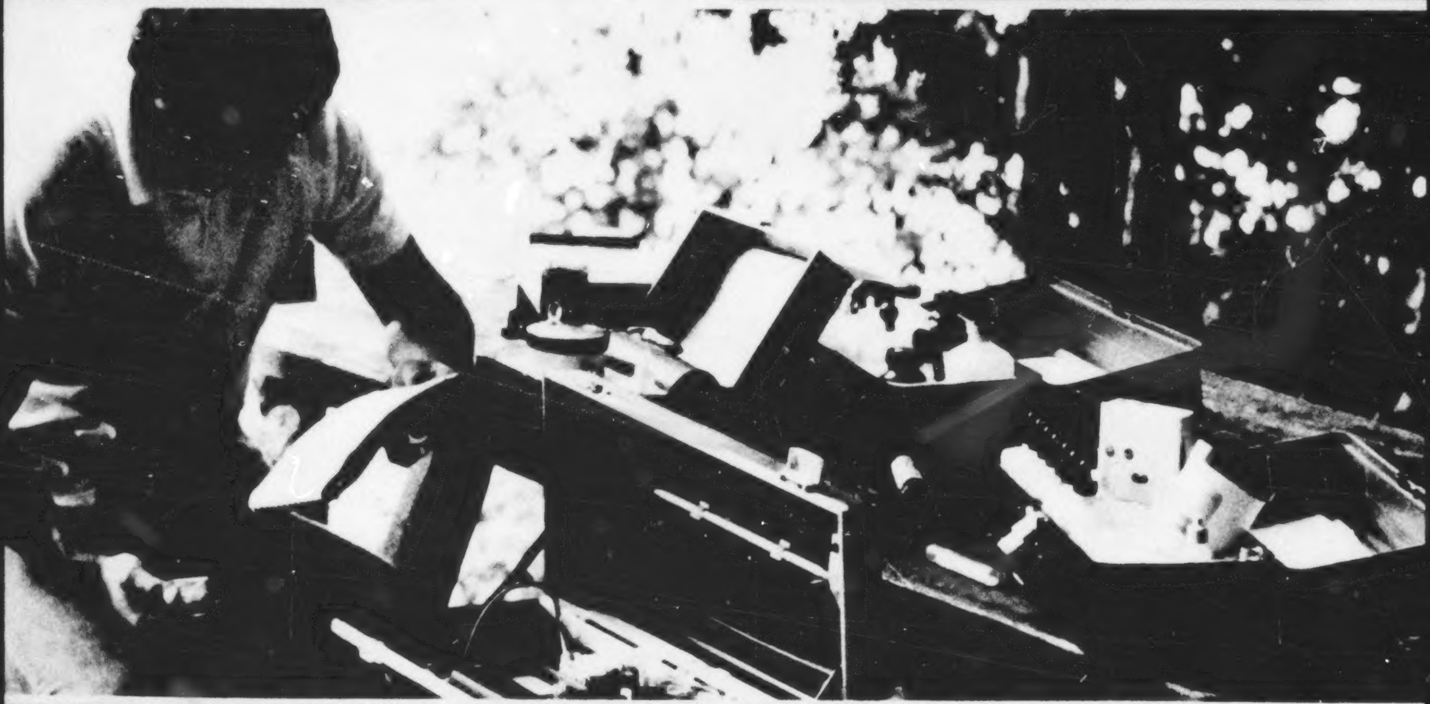
A basic law of physics that any presentation unit must deal with is Murphy's Law. Who Physicist Murphy was has been lost in the mists of time, but his law states, "WHATEVER CAN POSSIBLY GO WRONG, WILL GO WRONG AT THE WORST POSSIBLE TIME, THE WORST POSSIBLE PLACE, AND IN THE WORST POSSIBLE WAY." This means that the projector bulb will burn out right in the middle of the show, or someone will trip over the cord right before the climax of the narration. The best way to beat Murphy and his law is to BE PREPARED! Make a Murphy Box to hold a spare projector bulb, a spare extension cord, a three-pronged electrical adapter, a flashlight (power failure ?), and a spare projector cord. For good measure, bring along a roll of masking tape to tape down any cord crossing a traveled area, such as a center aisle. Between shows keep the film and the projector clean. Always clean the lenses of the projector with specially treated lens paper before each show. Prepare an inventory list to check off all items before departing for the show and check in after the show to ensure all equipment taken was returned.

G. Improving and Revising

Never let the show become set in its way. Continually experiment with different arrangements, narratives, and facts to get your message across. With enough revision it will be possible to show the same club at yearly intervals a newer show encompassing improvements every time. The pyramid effect will appear to you and your students. From each show you do, the word about your presentation will spread, and more offers will come to you. Don't be afraid to branch out, trying new themes, and offshoots of your original show. Different and more sophisticated camera techniques can be tried. If you have a number of slides to be processed, look into the possibility of the students doing the processing themselves. There are a number of slide processing kits available on the market, and your photo dealer should be eager to explain them to you. Possibly one of the most exhilarating moments experienced by a novice photographer is the instant the first roll of film he or she has ever developed is removed from the developing tank. This also allows a great improvement in technique, because the time between photographing and viewing is greatly reduced.

It will not take long for your group to become veterans at photographic presentations. It will leave its mark on the students through the confidence they gain in putting their ideas across to others. It may spark some into a career in the radio or television field. It may create a future professional photographer. It will certainly bring praise from parents and educators for the valuable service done for the community. The camera will only record what we wish it to look at. Through a strong photographic presentation, it can convince us to look at what we should have seen by now.





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XIII

ENVIRONMENTAL STUDIES PROGRAM

ST. ANSELM'S COLLEGE - MANCHESTER PUBLIC SCHOOLS

A. TERRESTRIAL ECOLOGY CURRICULUM

The planet on which humans live, to our knowledge, is the only planet as being capable of substaining life. We do know that when the astronauts cleared the far side of the moon, they let out expressions of great joy because the first thing they sighted was Mother Earth. It was not like Browning's, "Off in the Northeast Distance, Dawned Gibralta, Grand and Grey." No! Their hearts swelled to the most beautiful "Blue Orb" man has ever laid eyes upon. This is history. What man, woman or child has not thrilled to reproductions of their photography--the beautiful blue orb, with its fleecy white cloud cover and the color contrast of ocean, sea, lakes, mountains, and all that make our world a place of beauty, instead of the barren grey that meets the eye of the astronaut approaching the moon. How long will it take man to duplicate the moon colors?

Back here on earth, our slice of the "blue orb", America the Beautiful--for how long? "From sea to shining sea." Oh! Is that right? We have heard rumors! "The Pacific is Terrific and the Atlantic 'ain't' what it's cracked up to be." That's right! The Pacific is in a terrific state of cultural etrophication, from oil spills, sewerage, chemicals and other manmade effluents. The Atlantic--the poor Atlantic! Oxygen content down 12% and dropping, New York sewerage combined with Texas oil and chemicals from the entire eastern seaboard, have sounded the Cheney-Stokes.* Can man turn back the evil-tides of man in time to prevent eco-catastrophe? It is our fervent hope and desire that we can, and to this end dedicate this guide. This is not a panacea; it is a guide wherein we hope teachers and students together can find the approach best suited to their own phenomonology and their own niche. We hope it leads to greater concern and much more action in an attempt to improve the environment. With these thoughts we include this syllabus--hoping it helps you find your best approach.

B. PROJECT PROCEDURES

Part I: Terrestrial Ecology Units

The choosing of a unit of terrestrial ecology for class study, will depend upon where one lives, season of the year, permissiveness of your principal in regard to field trips, and other factors. For instance, in New England if one were to choose a unit on Flowering Angiosperms, he would have to start this unit in May when spring flowers make their first appearance. We suggest that for maximum coverage of the flowers and greater understanding of this class it would be a better time if one were to start in May and continue up into the summer. We start our unit, however, in the fall taking advantage of what flowers are left and, of course, the ultimate product of the plant, its fruit.

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*Death Rattle.

UNIT 1: Flowers and Flowering Plants--The Angiosperms

- a. Opening day--a rap session. How much do we know about plants?
- b. Life impossible without plants.
- c. **Second day- a comparison** of Angiosperms and Gymnosperms.
- d. An introduction to the Angiosperms--selected specimens from the herbarium. (Note: If you don't have a herbarium in your school, bring in samples from nature.)
- e. Lecture as to form, mode of life, distribution.
- f. Third day--the value of flowering plants, the flower defined, dissection of a flower.
- g. Fourth day--anatomy of the flower, essential organs, variation of flowers.
- h. Fifth day--a tour around the school grounds--old and new friends.

UNIT 1: Second Week

- a. Obtain a lily from the flower shop, a corn stalk with leaves (even if dried), a few blades of grass or cat-o'-nine-tail leaves as representative of the monocot. Obtain any of the wild dicots available, buttercups, waterlilies, primroses, asters, roses, or goldenrods.
- b. Compare and contrast the two types, using the bioscope on the smaller flowers.
- c. Discuss the larger dicots such as Maples, Cherry, and other trees as flowering plants. Use selected specimens from the herbarium that were pressed with flowers in place.
- d. Another tour around the school--have the students collect and identify the plants as to monocot or dicot classification. Have a session in the sun--or on the lawn, football field, patio--commune with nature--discuss some of the more exotic forms of species, i.e., orchids, etc.
- e. Lecture Pollination, fruits, and seeds--modes of travel and migration factors. Collect winged fruit and seeds for winter lab unit on seed dispersal mechanisms. Bring in maple samara, box-elder, red, sugar, various types. Bring in milk weed pod, dandelion flowers in seed, etc.
- f. Assign each student a project of collecting, identifying, pressing, and mounting twenty-five flowers each, (this is only five flowers a day for five days) due one week from Monday. Suggest a walk home instead of the bus with a sharp eye out for flowers. Detour by way of fields, empty lots, railway tracks, etc. Complete the collection on the weekend if you wish.
- g. How to remove the sample from the ground, how much to take, parts, roots, etc. How to remove the flower from the tree or bush without injuring the plant. How to press a plant for best results and permanency.
- h. Quiz--Angiosperms, Monocots, and Dicots.

UNIT 1: Third Week--Methods of Preparing the Plant for Pressing, Drying, and Mounting, with an Introduction to the Herbarium. Assigned Reading-- Systemic Botany Swingle, McGraw-Hill, New York. (Chapter 10).

- a. The plant press...content, position, changing the press, drying and pressures.
- b. Mounting..papers, types, glue, labeling, positioning, covers, etc.
- c. Storing the plants...what to use in the absence of a professional herbarium.
- d. Taxonomic rank...order of storage...genus, species, etc.
- e. Keys to the Herbarium.
- f. Lab unit on building personal plant presses--team teaching with Industrial Arts.

UNIT 2: Fourth Week--The Field Trip

1. Vital Instructions

   - a. How we dress under different conditions.
   - b. What we take along (needed items for a specific type of trip).
   - c. Recorders--taking of notes, recording all important factors for class discussion and rap sessions back at school.
   - d. Protective measures, cautions, parental permission, school permission. Ref. USOE Environmental Education Act/Grant/"Environmental Studies Guide." P.L. 91-516.

2. A Trip to a Coniferous Forest.

   - a. Identification--classify as to genus and species.
   - b. How to take samples--twigs, bark, cones and roots.
   - c. The use of the vasculum and other carrying devices in handling conifers.

3. A Second Trip to the Coniferous Forest: Soils.

   - a. A study of the forest floor: plants, animals, fungi, litter, all visual study. Ref. Chapter 10 Botany Robbins, Weies & Stocking, Wiley & Sons--3rd Ed.
   - b. Soil testing and collecting of samples, (Lamotte Soil Kits).
   - c. Return samples to the laboratory for standard procedures.
   - d. Photography unit active during entire trip.

4. A Laboratory Unit.

   - a. Methods of preserving coniferous materials.
   - b. Soil classification: sifting, grading, type, etc. (Physical).
   - c. Soil classification: LaMotte Kits and Standard Procedures. (Chemical).

5. Terrestrial Ecology Reading Assignment.

   - a. Chapter Fourteen--Fundamentals of Ecology by Eugene Odum, 1971 Edition. (Saunders).
   - b. Selected library assignments and homework for oral talks and rap sessions. Topics: The Worldwide Paper Shortage, Conservation of our Forest, Forest Fires and their Effects, good and bad, etc.

2. a. Field trip, same area--photograph and view from blinds.
   b. If art class is invited, sketching pads, crayons, charcoals, etc.
   c. Tape recordings of calls should be made.

3. a. Lecture, economic importance of birds, i.e., agriculture, guano, recycling phosphates.
   b. Monitors of pesticides, DDT, herbicides, etc.
   c. Insect control.

4. a. Guest speaker from local chapter of Ducks Unlimited--talk on Management of Wetland Areas.
   b. Rap session.

5. a. Ornothologist from College or University--lecture. (NOTE: bird unit will continue in the spring).

UNIT 4: Ninth Week--Soils

1. Types--Classification.

   a. Field trip to a gravel pit--profiles, humus, levees, etc.
   b. Equipment USDA sieves--soil samples, core borers--containers.
   c. Sift, grade, classify--return to lab and weigh.

2. Laboratory: desiccate, weigh, and classify

3. Lecture: characteristics of selected soil types by member of Earth Science Dept.

4. Guest lecturer, soil scientist--soil conservation services.

5. Rap session.

UNIT 4: Tenth Week

1. Testing--1st week's coverage of soils.

2. Soil fertility and depletion factors

3. Field trip to Rock Rimmon--ledge outcropping.

   a. Equipment: chipping hammers, chemicals and containers.

4. Trip to Blueberry Hill--soil erosion--hill and gully.

5. Movie--Soil Depletion and Conservation Measures.

UNIT 5: Eleventh Week--Aquatic

1. Freshwater Ecology--Chapter 12 Odums, Fundamentals of Ecology, (week's reading).

   a. Develop the chapter.
   b. Field trip to Lake Massabesic (or your favorite pond).
   c. Equipment: HACH kits, Millipore equipment, Secchi disks, bottom samplers.
   d. Collect and test.

2. Laboratory--Test Yesterday's Water Collection.

   a. Dissolved oxygen, CO_2, SO_4, PO_4, NO_2, NO_3, Cl, pH, turbidity, etc.

3. Films and video tapes of pollution along the Merrimack River.

4. Rap Session--What can we do? Who to blame? Economics control?

5. Test of Chapter 12, Odum.

UNIT 5: Twelfth Week--Marine Ecology (ref. Ch. 13 Odum Fundamentals of Ecology)

1. Lecture--Salinity, pH.

2. Lecture--Fauna.

3. Lecture--Flora.

4. Lecture--Tides

5. Lecture--Global Cycling of Minerals.

   a. Weekend trip to Dover Point and Seapoint Beach.

UNIT 5: Thirteenth Week--Esturarine Ecology (ref. "Odum" Fundamentals of Ecology,

1. Term Paper: "Population and Pollution of the Bio-sphere."

2. Instructions for Paper.

3. Research Debate Topic: Oil Refinery at Durham Point and the Atomic Plant at Seabrook, New Hampshire.

4. Research and Prepare Debate Topic (NOTE: Team teaching with the English Dept.).

5. Debate.

UNIT 5: Fourteenth Week

1 - 5: Review eleventh week's work: Under Frozen Lake Conditions

UNIT 6: Fifteenth Week--Winter Woods (ref. Shrub and Tree Identification, Symonds)

1. Lecture on use of winter keys for trees and shrubs, by Curtis and Cottam, Plant Ecology Workbook, 1964. Burgess Publishing Co.

2. a. Identification of hardwoods by leaf scars, scales, buds and taste.
   b. Making a grid map of the area and netting genus and species present.

3. Return to Mount Saint Mary's Forest.

   a. Quadrats and Quadrangles: Measurements of relative frequency, density, and dominance.

4. Back to the Forest

   a. Determining how old a tree is: increment borings and ring counts.
   b. DBH (Diameter Base High).

5. Rap Session--Value Judgements on the Forest Ecosystem.

6. Test over week's activities.

UNIT 6: Sixteenth Week--Winter Woods (continued) Softwoods

1. Quadrats and Quadrangles.

   a. Using the keys for softwoods.
   b. Identification of softwoods in the winter conditions. (Seales, Cones, Buds, Needles).

2. Increment borings and ring counts, determining the age of the tree.

3. Grid mapping--genus and species.

4. Rap Session--Value Judgements.

5. Test over week's activities,

UNIT 7: Seventeenth Week--Mid-Winter Forest Animal Study

1. Track Identification,

   a. Keys to animal tracks.
   b. Permanent records of animal tracks using plaster casts and epoxy casts.

2. Use of Black Carbon Papers and Seat Boards.
   a. Bird tracks and animal tracks.
   b. Other tracking methods.

3. Locating Animal Homes.
   a. Caves, hollow trees, winter nests, holes, rock formations, etc.
   b. Beaver ledges, squirrel nests, hawk nests.

4. Study of Deer Years--Field Lectures, N. H. Fish and Game Department

5. Quiz over week's activities.

UNIT 7: Eighteenth Week--Laboratory Study Unit: (ref. Plant Ecology Workbook, Curtis and Cottam)

1. Wind Tunnel Lab on Dispersal of Seeds. (NOTE: All seeds have been collected on prior field trips).
   a. Lecture on seed dispersal mechanisms.
   b. Building a wind tunnel (by the students).
   c. Materials: Plexiglass box, automotive fan or heater blowers, Rheostat, furnace pipe, sheet metal for directional vanes, sod, soil, miniature trees, bushes, grasses, stuffed animals.

2. Studying various holdfast methods, wind-borne dispersal mechanisms and methods observed. Favorable location results--growth patterns.

3. Continue the study of selected seeds: acer, aster, catalpa, salix, tillia, milkweed, and dandelion.

4. Write up laboratory reports and results, also observations of results in wind tunnel to date.

5. Using dewinged seeds compared to winged.
   a. Distances travelled, weight (dry), amount of water displacement per seed, volume per seed, specific gravity of seeds. (NOTE: Water displacement and volume were recorded in the fall at time of collection.)
   b. Rap session.

UNIT 7: Nineteenth Week--Woody Plants

1. Lecture--Roots and Their Structures.

UNIT 2: Fifth Week--The Moose Spruce Biome, McGraw-Hill Films

a. Rap session.
b. Guest lecturer--forester on economics.
c. Selected slides on conifers.
d. A trip to a nearby lumber yard.
e. Rap session.

UNIT 2: Sixth Week--Parasitology--Pestilence and Pathology

a. Saw flies, white pine blister, rusts, fungi.
b. Guest lecturer on some of the above problems (State Forester).
c. Review Chapter 14 and notes for test.
d. Continue review of notes and Chapter 14 Odum for test.
e. Test on Chapter 14 and notes to date.

UNIT 3: Seventh Week

1. A Nature Stroll to a Swamp and Hardwood Forest

    a. Equipment: binoculars, cameras, sketching pads and crayons. (NOTE: Photos will be taken of both male and female birds of the same species in all seasons, where applicable.)

2. Lecture (Field or Classroom) Structural Characteristics, Feeding Habits, Flight Patterns and Characteristics of Birds

3. Nesting Requirements: Where to Look and Where to Find, Scarcity.

4. Importance of the proximity of feed for birds during nesting time, bird calls and significance, variation of calls during mating season and their interpretation, mating characteristics

5. Visual perception among birds. (Assigned reading--Scientific American--Offprint).

UNIT 3: Eighth Week

1. Field Trip: To Upland Hardwood Forest. Ref. Ch. 18, Botany, Robbins, et al. Wiley and Sons, 3rd Ed.

    a. Set out knickknack inducers, birch log feeders and woodland bird baths. (Equipment: see homemade equipment sheet and section #1 Unit 3: 7th week.)
    b. Set up bird blinds to observe birds and to photograph same. (NOTE: blinds must be made of materials available in the immediate area, or birds will not cooperate.)

   a. Selected slides of monocot and dicot roots.
   b. Diagrams and drawings of microscope slides.
   c. Types of roots.

2. Selected Roots from the Herbarium and Florists.

   a. Dissection--cross section, longitudinal section, sagittal section.
   b. Drawings.

3. Lecture--Transport, Osmosis, Root pressure, Turger pressure, minerals and nutrients.

   a. Lab--set up for osmosis and diffusion.

4. Root Modifications, Structural and Supportive Functions.

5. Quiz on Roots.

UNIT 7: Twentieth Week--Woody Plants (continued)

1. Stems, Limbs, Twigs and Trunk.

   a. Structures--vascular bundles, types and functions.
   b. Selected microscope slides--drawings.

2. Lecture--Bark and Cambium.

   a. Primary growth.
   b. Secondary growth.

3. Laboratory Using Selected Stems and Barks from the Herbarium.

4. Review for Test.

5. Test Roots and Stems.

UNIT 7: Twenty-first Week--Woody Plants (continued)

1. Study of Leaves.

   a. Selected specimens from florist and herbarium.
   b. Leaf structure and function.

2. Lab--Drawings of Leaf Structure, Cross-section and Longitudinal Section From Selected Slides.

   a. Dissection of the leaf-florist specimens.

3. Lecture--Function of the Leaf--Transportation, Transpiration, Abscission Layer, Turger, Wilting

4. Photosynthesis, Cyclic Photophosphorylation

   a. Lab--extraction of chlorophyl (Argonne method).
   b. Chromatography (Argonne method).

5. Quiz on Leaves.

UNIT 7: Twenty second Week--Maple Syrup Unit: (Field and Lab)

1. Equipment: Gallon plastic milk containers, nails, spouts (made by Industrial Arts Department); sheet metal, or tin cans, wood auger (large bit 3/4" and a hand drill, evaporating pans for laboratories (NOTE: must be done in lab, time factor); hot plates, Bunsen burners and cheese cloth, sugar molds for candies, transporting buckets.

   a. Selecting and tapping the trees.
   b. Transporters to cook back at laboratory.

2. Cook and continue collections (all classes).

3. Making candies and syrup.

4. Quality control.

5. Packaging and delivery to orphanages.

UNIT 7: Twenty-third Week

1. Field Trip: Harvard Herbarium (all day).

   a. Works of Paul Revere, Hawthorne, and Thoreau.
   b. Glass flower museum at Harvard.

2. Rap Session over Field Trip--Value Judgements.

   a. A discussion of the Revere collection and others.
   b. From West High School--the Sargent Collection of the Wolfboro triplicates. (Herbarium).

3. Movie--St. Regis Paper Co.--Conservation Series--Planting.

4. Guest Speaker--New Hampshire Society for the Protection of Forests.

5. Rap Session--Values.

UNIT 8: Twenty-fourth Week--Building and Setting Out of Duck Boxes

1. Construction Materials: Left-over Pine Board Scraps, Nails, Hammers, Saws, Miter Boxes
    a. Drawing of blue prints under the direction of Industrial Arts students.
    b. Start construction and continue.
2. Continue Construction
3. Finish Construction.
4. Field Trip to Massabesic Lake--at the Fang.
    a. Set out boxes.
    b. Notify Fish and Game Department.
5. Field Trip to Hinmon Pond--Set out Rest of Boxes.

UNIT 8: Twenty-fifth Week

1. Making of Birds Nests.
    a. Materials--construction and design, Industrial Arts students.
    b. Construction--ecology students--assisted by Industrial Arts students.
2. Continue Construction of Bird Houses.
3. Lecture--Audubon Member--"Where and How to Erect Bird Houses,"
4. Placing of the Houses on Trees and Poles.
5. Observation of all Activity and Recording of Species Plus any Nest Building in the Area.

UNIT 8: Twenty-sixth Week

1. Continue Observation of Birds.
    a. Students list types as to species.
    b. Make a grid map of areas where sighted.
2. Rap Session.
3. Movie--*Cry of the Marsh*.

4. Lecture on Endangered Species.

5. Selected Slides of Birds of our Area and their Economic Importance.

UNIT 9: Twenty-seventh Week--Metamorphosis

1. Field Trip to Deerneck Brook, Auburn, New Hampshire.

   a. Equipment: homemade macro and microplankton nets (ref. Environmental Studies Guide O. E. Environmental Education Act, Manchester Public Schools and St. Anselm's College, 1972). Also stream sampler, jugs, jars, preservative, labels and keys.
   b. Collect, preserve, key and return to lab with specimens.

2. Continue keying out Unknowns and Labeling.

   a. Build cigar box and styrofoam carrying units; pin better specimens.

3. Lecture: Insect Larval Forms, Brooks and Ponds. (Ref. Assigned reading--Freshwater Ecology, Prentice Hall, 1971 Ed.)

4. Movie: Beneath Our Feet, Insect Coverage.

5. Quiz on Metamorphosis.

UNIT 9: Twenty-eighth Week--Insect Collection.

1. Making of Insect Nets: Laboratory Function.

   a. Equipment: wire coat hangers, cheesecloth, old broom handles or small saplings, needle and thread, wire.
   b. Collecting in field across from school on the lawn, on the patio, in the tree grove at the end of the football field.

2. Keying out Yesterday's Collection.

3. Mounting and Labeling.

4. Lecture: Entomologist from the University of New Hampshire.

5. Dissection of the Lubber Grasshopper.

UNIT 10: Twenty-ninth Week

1. Lecture--Succession; Forest Succession.

    a. Two leading theories.

        1. Fire.
        2. Hurricanes.

2. Trip to a Burned Woodland, Camera Units, LaMotte Soil Kits, Assess and Analyze.

3. Lecture: The Blow Down Theory, as proposed by Dr. Ruppe of Harvard's Petersham Forest.

4. Eutrophication--Cultural and Natural--in Ponds and Lakes.

5. Movie: Fo[illegible]t Fires.

UNIT 11: Thirtieth Week

1. Spring Bud Study.

    a. Useful in keying.
    b. Development of buds, types, location.
    c. Collecting for the herbarium.

2. Field Trip Around the School for Own Bud Collection.

3. A Study of Selected Planted Trees, Horsechestnut, Catalpa, Alianthus, and Others.

4. A Study of Selected Maples Around School Area.

5. Practical Lab Test on Buds.

UNIT 12: Thirty-first Week

1. Movie: Video Tapes--Beaver 1 and 2.

    a. Rap session.

2. Trip to a Beaver Dam at Kennicum Swamp.

    a. A look at beavers.
    b. Otter scat (hopefully otters).
    c. Squirrels and other animals in the swamp.

3. Mouse Population Study--Field in Back of School.

    a. Equipment--small traps and peanut butter.

4. Tend Traps and Collect.

5. Rap Session.

UNIT 13: Thirty-second Week

1. Spring Turnover of a Lake.

   a. Lecture on turnover--conditions (ref. Odum, Freshwater Ecology).

2. Trip to Massabesic Lake.

   a. Determination of thermocline.
   b. Determination of compensation level.
   c. Turbidity, D.O., PO_4, SO_4, Temp., Chloride, and other tests.

3. Rap Session on Observed Results and Notes.

4. A Comparison with Data and Graphs of Fall Trip.

5. Test on Freshwater Ecology.

UNIT 13: Thirty-third Week

1. A Study of Aquatic Plants: (Ref. Norman C. Fassett, University of Wisconsin Press).

   a. Stevens Pond--the algae.
   b. Elodea.

2. Stevens Pond--The Bladderworts.

   a. Utricularia vulgaris.
   b. Utricularia pupurea.
   c. The stoneworts--Charta.

3. Special Field Lab on Pressing Aquatics.

4. Proserpinaca, Hornworts, Ceratophyllum.

5. The Spermatophytes of the Pond--Lecture.

UNIT 14: Thirty-fourth Week

1. Fungi--Pine Forest--Mount Saint Mary College.

    a. Basidiomycetes--brackett fungi--toadstools.
    b. Ascomycetes--morels.
    c. Slime--molds--staminitis.

2. Smuts and Rusts--White Pine Blister.

    a. Currants and gooseberries.
    b. Cedar rust.
    c. Downy mildews.

3. Lecture Over Fungi--Morphology--Physiology.

    a. Edible forms.
    b. Poison forms.

4. Economic Importance.

5. Quiz--Fungi.

UNIT 15: Thirty-fifth Week--Field Trip to Kennikum Pond

1. A Trip to the Bog.

    a. Lecture on a glacier-formed bog.
    b. Carnivorous plants--drocers and saraconea.
    c. White and yellow grass flowers.
    d. Sphagnum (5 types).
    e. Water-willows.
    f. Dwarf mistletoe (on black spruce).
    g. Vaccinium macrocarpon and microcarpon.
    h. Decadon, galium, hepericum.

2. Back to Kennikum.

    a. Woodland flowers--viburnums, violets, lilies, iris, bluettes, bogwood, rhus, collect, and press (vasculums).

3. Press the Collection: Identify and Label

4. Quiz: Flowering Plants.

5. Flowers of the Field--Across from School.

UNIT 16: Thirty-sixth Week--Marine Ecology

1. Trip to Dover Point and Sea Point Beach at Kittery, Maine.

a. Animals of the flats at Dover Point, Horseshoe crabs, snails, worms, comb jellies, clams, oysters, echinoderms, fish of tidal pools.
b. Plants of Dover Point: algae, eelgrass, sedges, beach peas, goldenrod, prunus maritina, and others.
c. Kittery Point--rock weeds, starfish, urchins, barnacles, sand dollars, mussels, brittle stars, etc.
d. A swim at Hampton Beach State Park.

ENVIRONMENTAL STUDIES PROGRAM

The Manchester Public School students utilizing the entire community as their classroom, along with the student-made equipment in this guide, have been able to overcome financial problems confronting many schools and obtain a good comprehensive knowledge of environmental issues they must face now and in the future.

The ENVIRONMENTAL STUDIES PROGRAM activities may be summarized as follows:

I. The City-wide Curriculum Development Program in Environmental Studies. This includes formal ecology classes in some schools and interdisciplinary classes along with demonstration units in other classes.

II. The West High School Demonstration Unit. This is a group of Ecology I students who travel throughout the city, visiting other schools and civic organizations demonstrating how to use the equipment illustrated in this guide plus HACH and Millipore equipment.

III. The Environmental Presentation Unit. This is a group of high ability students from Ecology II class, or advanced ecology students. They put on a slideshow, movie or video-tape shows they have produced on pollution. This group has put on an average of 200 showings a year all over New England.

IV. A Curriculum Guide to Environmental Studies. Produced by Manchester teachers and others throughout New England, this guide offers a collection of outstanding curriculum developments by teachers and students in the field of Environmental Studies.

V. The Teacher Training Unit. This is a group of highly dedicated teachers who train other teachers throughout New England. This is done after school and on weekends.

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